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A. S. M. E. ANNUAL MEETING NUMBER

JANUARY 1920

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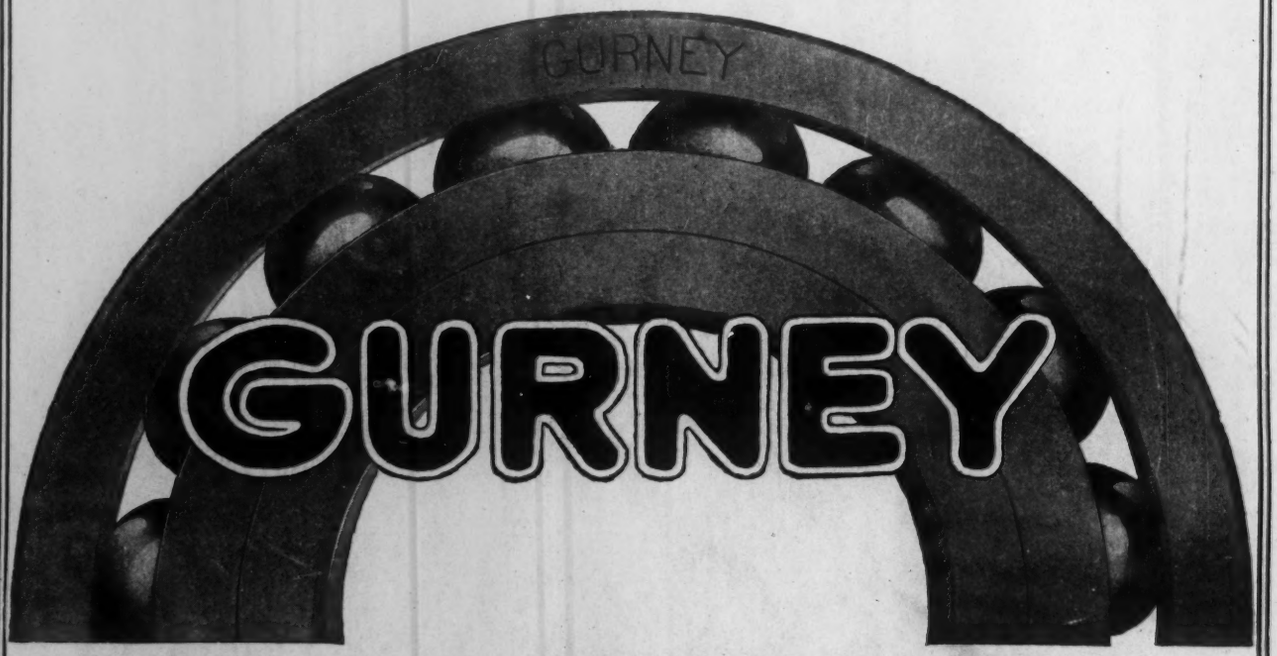

Mechanical Engineering

The Journal of The American Society of Mechanical Engineers

VOLUME 42 JANUARY, 1920 NUMBER 1

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PUBLISHED MONTHLY BY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West Thirty-Ninth Street, New York

PRICE 40 CENTS A COPY, $4.00 A YEAR; TO MEMBERS AND AFFILIATES, 30 CENTS A COPY, $3.00 A YEAR. POSTAGE TO CANADA, 50 CENTS ADDITIONAL; TO FOREIGN COUNTRIES, $1.00 ADDITIONAL

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Entered as second-class matter, January 4, 1912, at the Post Office, New York, N. Y., under the act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 8, 1918.

NATIONAL DEPARTMENT OF PUBLIC WORKS ASSOCIATION

Convention, Washington, D. C., January 13-14

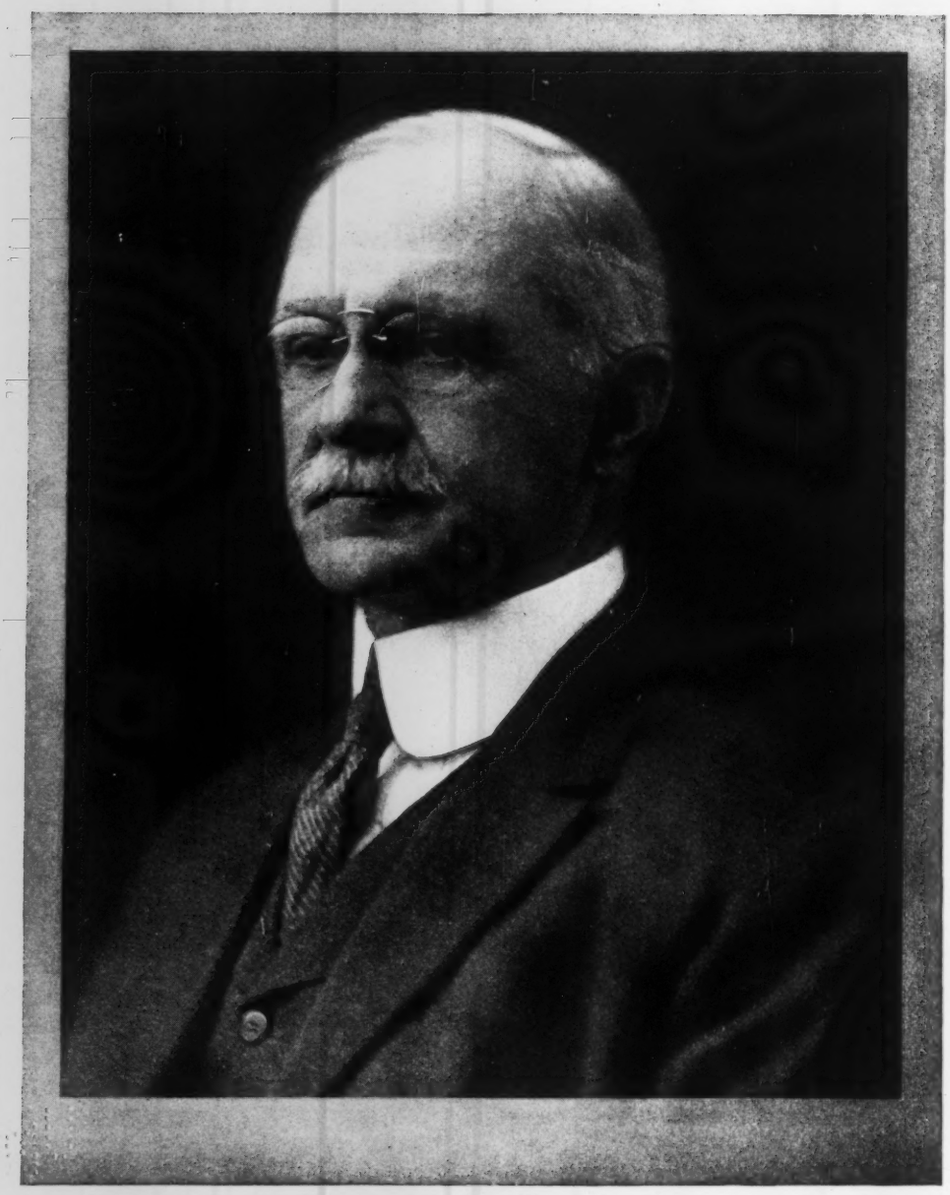
THE movement to establish a National Department of Public Works initiated by the technical men of the country, and which took definite form at Chicago last April, is now a live National issue. It is the first National campaign in which the engineers of the United States have united. Having started the movement they cannot afford to fail in their support of it.

A convention has been called to intensify the interest in the movement, to broaden the scope of the organization, to discuss procedure, and to adapt our activities to the developments that have taken place since last April. This will be held at the Willard Hotel, Washington, D. C., January 13 and 14.

Effort has been made to invite all engineering organizations in the United States but it may be that some have been unintentionally overlooked. The National Public Works Department Association earnestly desires that all such organizations shall regard this announcement as a direct invitation to them to send delegates. All accredited representatives will be heartily welcomed.

The fundamental reason for a Department of Public Works is to secure efficiency and economy in the conduct of Government business. The Secretary of the Treasury recently submitted a $5,000,000,000 budget to cover expenses for the next fiscal year. We are paying too much for what we get and all measures of economy will be futile until we bring order and organization out of the chaos of our Departmental activities. To this purpose we have pledged ourselves, and every engineer is summoned in support.

M. O. LEIGHTON, *Chairman Executive Committee.*
National Public Works Department Association.
McLachlen Building,
Washington, D. C.



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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 42 January, 1920 Number 1

A Dredging Pump of Novel Construction

By WALTER J. WHITE,[1] NEW ORLEANS, LA.

THE port of New Orleans has long been denied its natural growth by restrictions imposed by the civil code of the state of Louisiana, which declares that the banks of all navigable rivers are public property and as such cannot be sold nor used for factory sites, shipyards, or other industrial enterprises. Attempts have been made to overcome this industrial handicap by proposals to build a navigable canal which would not be subject to the restrictions just enumerated. Some fifteen years ago Mr. Walter Parker proposed that such a waterway be built connecting the Mississippi River with Lake Pontchartrain, but the task was not undertaken until shortly before the war.

It is not the purpose of this paper, however, to deal with the history of this canal nor to present the many industrial advantages which its creation will bring to the port of New Orleans, but rather to present some of the outstanding engineering features incident to the completion of the work.

It may be of interest to note in passing, that in spite of the prevalent belief that the civil code has been a handicap to the general industrial development of New Orleans, even if there were no law standing in the way, manufacturing plants located upon the Mississippi would be exposed to many dangers occasioned by the encroachment of the river. Furthermore, any manufacturing plant due to the great range of level of the river would be burdened with the cost and inconveniences of loading and unloading of water craft and such fact would serve to make impracticable the operation of the plant. It is also generally conceded by experts in shipbuilding that operations of that kind could not be maintained on the banks of the river with any hope of success. It is of course obvious that an inner-harbor navigation canal (controlled by locks) would be entirely suitable for all such purposes.

During the construction of the canal the very unusual character of the dredged material necessitated a complete change in the construction of the dredge pumps, and because the engineering features are particularly interesting, it is to this phase of the work that the writer wishes to direct attention; but before proceeding to examine the methods employed, a brief description of the canal itself will undoubtedly be of interest.

The surface elevation of that part of the city of New Orleans in which the canal is located is the same as mean gulf level. Occasional high tides, due to storms, occur when the water rises to an elevation of from three to five feet higher than the ground surface. It was therefore desirable that the dredge excavation be handled in such a way that the greatest benefit would be secured from the disposal of the material. This was accomplished by depositing the dredged material so as to form as nearly as practicable a continuous fill, which thus serves as a levee along both banks of the canal and which prevents any possibility of overflow during storm tides. The dredge excavation furthermore provides high, well-drained sites for shipyards and other industries. The length of the Inner Harbor - Navigation Canal from deep water in the Mississippi River to the 14-ft. contour in Lake Pontchartrain is 31,800 ft. The completed project is to have a clear channel width of 150 ft. or the bottom with a depth of 30 ft. below low water. In the development of shipyards and other industrial sites no encroachment on the channel width will be allowed, such locations being provided with launching basin, slips, piers, etc.

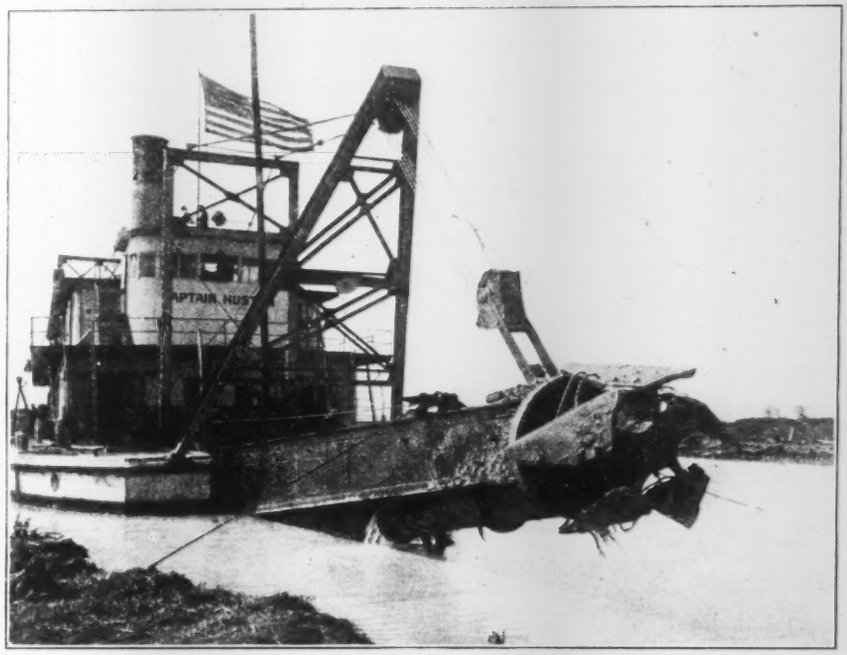

FIG. 4 THE DREDGE *Captain Huston*, USED IN THE EXCAVATION OF THE NEW ORLEANS INNER-HARBOR NAVIGATION CANAL

While it is true that the Mississippi River and Lake Pontchartrain will be connected, it is believed that the use of the word canal is misleading and very likely to be misunderstood. It should be remembered that Lake Pontchartrain is a shallow body of water when compared with the depth of 30 ft. in the inner harbor. The present plan contemplates the construction of an inner harbor, or basin having a constant level and connected with the deep-water channel of the Mississippi River, entrance from the river channel to the inner harbor being by means of one lock. After the harbor feature has been considerably developed, it is quite probable that extensive dredging operation will be undertaken to establish a deep-water channel from the north end through Lake Pontchartrain and Mississippi Sound to the Gulf,

[1]Supt. of Dredging, Board of Commissioners, Port of New Orleans. Assoc.-Mem.Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

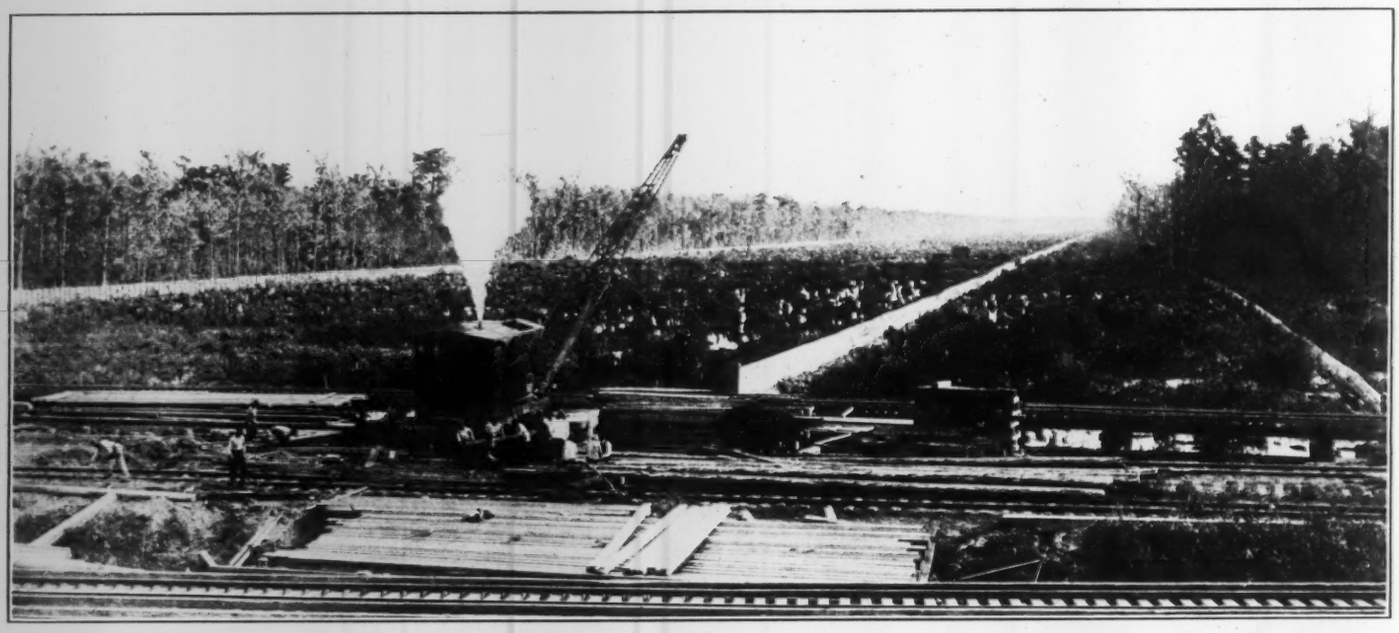

FIG. 2 VIEW OF CANAL SITE LOOKING SOUTH FROM THE RAILROAD

thereby justifying, in the fullest sense, the name Inner Harbor-Navigation Canal—an *Inner Harbor* having a constant level and a *Canal* connecting deep water in the Mississippi River with deep water through Lake Pontchartrain to the Gulf.

During the construction of the canal, traffic had to be maintained over railroads, electric-car lines, and highways which crossed the line of the Inner-Harbor. This feature and the necessity of utilizing the excavated material in levees and fills along the banks, and also the requirement that all excavated material be deposited well back from the edge of the bank, prohibited the use of dipper dredges or other types of dredges which dispose of material by means of scows or by depositing along edge of cut.

While planning methods by which this dredging could be done economically, and at the same time rapidly, several test pits were excavated which confirmed the belief that about 80 per cent of the area to be excavated was underlaid with large cypress stumps which at some time in the past had either subsided or had been covered by deposit from overflow. In addition to the submerged stumps there was a heavy surface growth of cypress and other timber from Station No. 88 to Station No. 221. The topography of this country is best shown by Figs. 2 and 3. After clearing the standing timber from the area to be dredged tentative efforts were made to remove all stumps by shooting and grubbing, but it was found that this would greatly increase the cost of the work. During the progress of the work very little manual labor was expended on stumps and roots, although it was found to be advantageous to blast some of the larger surface stumps.

Notwithstanding the great number and character of stumps and roots, as evidenced by Fig. 4, it was decided for the reasons mentioned that the work could best be done by hydraulic pipe-line dredges of the cutter type and contractors were asked to submit bids on the work. Due to the difficulties mentioned, however, contract prices could not be secured and arrangements were therefore made to charter dredges, the Board of Port Commissioners accepting all responsibility for output. Four 20-in. dredges, and one 22-in. dredge, the *Texas*, were accordingly secured and work was commenced on May 15, 1918. Fig. 1

FIG. 3 VIEW OF CANAL AFTER EXCAVATION

shows one of these dredges, the *Captain Huston*. The dredges were powerful machines of good design in all respects, but it was fully realized that much trouble was to be expected on account of stumps and roots.

By utilizing Bayou Bienvenue four of the dredges were brought in to a point on the canal near Station No. 88, where one was placed in operation headed toward Lake Ponchartrain and three were started toward the Mississippi River; one dredge was also started south from Lake Ponchartrain. On account of large areas in suction and discharge pipes and pump, the 22-in. dredge *Texas* was placed in the most difficult section. After allowing a reasonable time for dredge and crew to become adjusted to conditions, it became evident that progress would be slow and the work would be expensive, due entirely to delays and decreased capacity occasioned by stumps and roots clogging pump throat and suction. The soil itself was easily handled by a hydraulic dredge and the pipe-line conditions were not difficult, but the amount and character of roots encountered and later successfully handled is beyond description. Fig. 5 shows the character of the material actually pumped through the dredge *Texas*. It was thought that the solution of this difficulty would be found in a pump impeller designed with large and easy passage areas and having no projecting webs on vanes or hub. The writer learned that Mr. A. B. Wood, mechanical engineer for the Sewerage and Water Board of New Orleans, had designed and patented a centrifugal-pump impeller for handling sewage containing trash. An impeller for a 12-in. pump was inspected, and while none had heretofore been used on dredges of the cutter type it was believed that the root problem was solved and Mr. Wood was engaged to design an impeller for the 22-in. dredge *Texas*. All costs in connection with the manufacture of the impeller were to be borne by the Board of Port Commissioners regardless of whether or not it proved a success.

From the first the results obtained with the new impeller were remarkable, the increase in output being between two and three hundred per cent. The increased yardage excavated by the dredge *Texas* is shown by the following comparative statement, covering thirty days' operation immediately before and immediately after substituting Mr. Wood's impeller for the old type:

	Old Impeller	New Impeller
Excavating, hours	482.43	394.00
Clogged suction delay, hours	130.75	71.50
All other delay[1], hours	106.82	254.50
Advance, feet	873	2,901
Excavated material, cubic yards	73,472	175,460
Average yardage per excavating hour	152	445

FIG. 4 CHARACTER OF EXCAVATION ENCOUNTERED

The operation and output of the 20-in. dredges *Captain Huston* and *Dixie* was very greatly facilitated and increased by certain modifications made in pump casings and impellers. Area in pump throat was increased by changing the shape of the throat ring and fitting a new piece of suction pipe. As previously mentioned, it was recognized that in order to secure maximum output in material of this character, it would be necessary to provide as large passages through pump and impeller as possible, and it was therefore determined that two-thirds of each alternate vane should be cut out of the impellers in these dredges, as shown in Fig. 6 and 7. The outer one-third of the vanes was left to preserve structural strength, but after observing the performance of the pumps it is the opinion of the writer that every alternate vane could have been entirely removed.

During the first three days that the dredge *Captain Huston* was in operation and prior to making alterations to the pump the yardage output of the dredge was practically nothing. This was due to the fact that the pump-suction throat was continuously clogged with stringy roots and stumps, which it was impossible for the pump to handle. Conditions could not have been worse and it was felt that any method whereby the pump throat and impeller could be opened up would result in an increased output. It is admitted that some uneasiness was felt as to how these alterations might effect the performance of the pumps, but results have more than justified what at first seemed to be a drastic and

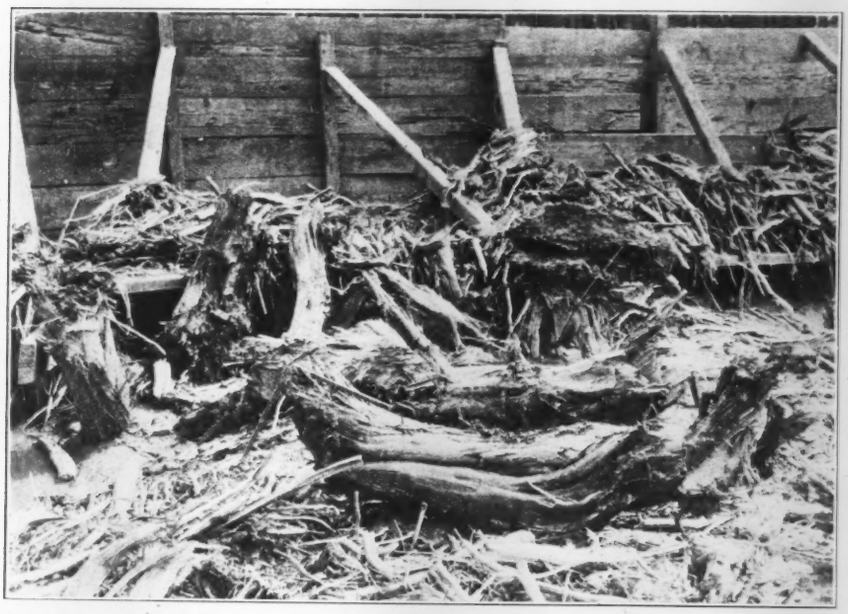

FIG. 5 STUMPS AND ROOTS HANDLED AND ACTUALLY PUMPED BY THE DREDGE *Texas*

[1] The large number of delay hours after installation of new impeller was due to time lost cleaning boilers and raising a sunken fuel barge. For the period covered in the tabulation it will be seen that although the installation of new impeller decreased the number of excavating hours, the average advance in yardage was much greater. From observation of the dredge in operation it was seen that the ability of the impeller to pass stumps and roots insured the maintenance of a satisfactory output.

hazardous measure. Pump and engine tests, typical curves of which are shown in Fig. 8, have shown that these alterations did not effect the capacity or efficiency of the pump, other than by greatly facilitating the passage of roots, etc., through the pump. While the writer understands that radical alterations should not be made without careful consideration, it is undoubtedly true that the performance of a dredge is to be judged largely, if not solely, by the unit cost of output, and where for any reason output is not being secured any modifications of plant are justified, provided that the unit cost of output is controlled. In this particular instance there was involved the difference between failure and success. Assuming the same general character of excavation, a further modification along the lines indicated would, it is believed, result in a further increase in output.

The impeller designed for the 22-in. dredge *Texas* was of same diameter (80 in.) as that of the old impeller, but it had two instead of four vanes. An examination of Figs. 9 and 10 will show that, due to the peculiar shape of vane, the lodging or collection of roots or other material is made difficult, if not impossible, every encouragement being given by shape of vane and throat of impeller to the continuous flow of water containing irregular shape roots or other objects. The writer does not wish to convey the impression, however, that all of the large cypress stumps and roots were cut up by the cutters and handled through a 20- or 22-in. dredging pump. While suction ladders were built for heavy service and cutters were of good design and powerful, a great many of the stumps were undercut and allowed to sink to the bottom, where they were deposited below grade.

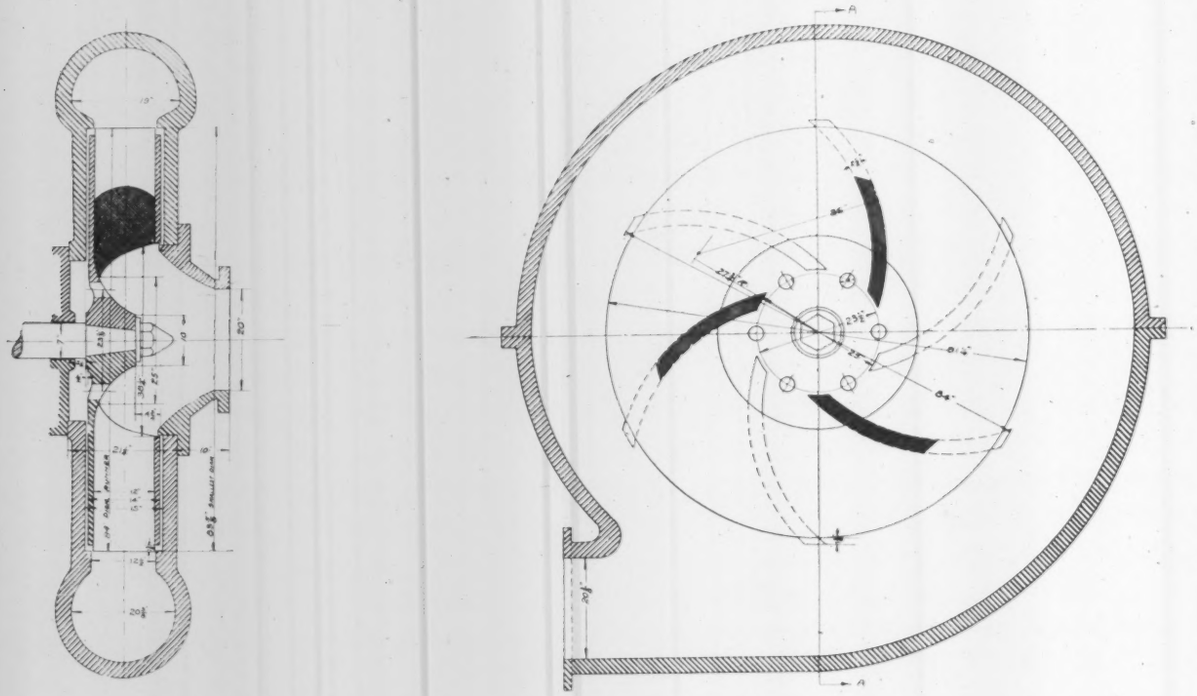

FIG. 6 DETAILS OF PUMP ON DREDGE *Dixie* SHOWING THE MODIFIED THROAT AND IMPELLER

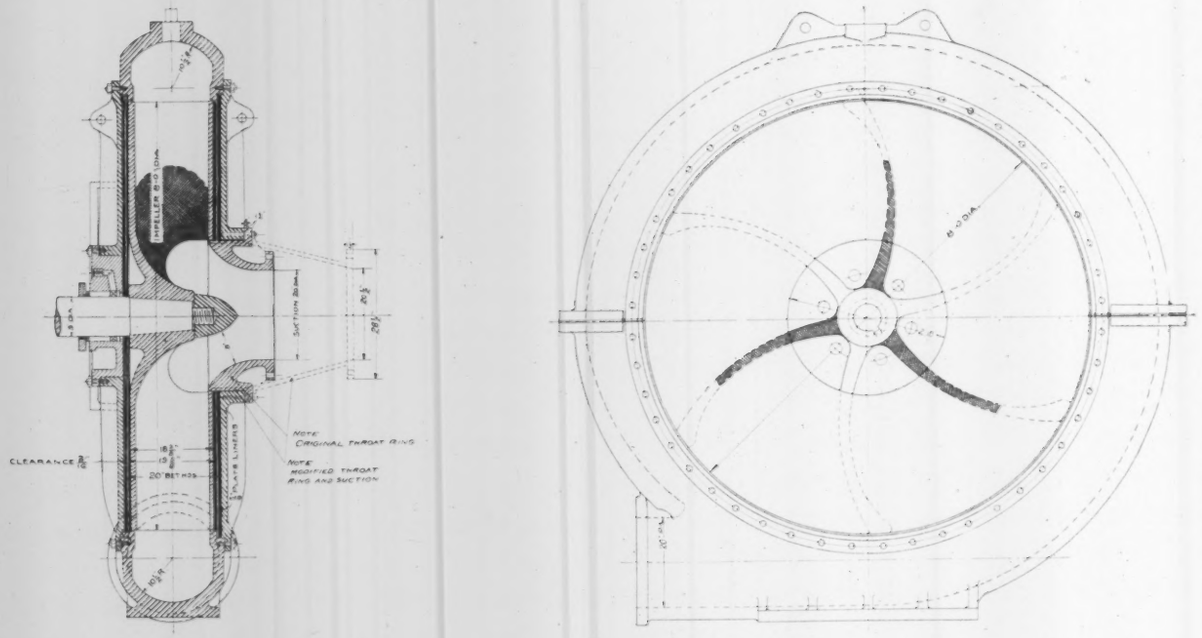

FIG. 7 DETAILS OF PUMP ON DREDGE *Captain Huston* SHOWING THE MODIFIED THROAT AND IMPELLER

In general the operation and maintenance of the dredges followed the usual procedure for dredges of this type, and it is not believed that any novel feature other than in connection with modification of pump design can be presented. The 22-in. dredge *Texas* was equipped to use ball joints as connections between sections of pontoon pipe, and it is believed that the passage of roots was made easier than if rubber sleeves had been used.

Pump impellers having two, three, four, six, and seven vanes and varying in diameter from 68 in. to 96 in. were used in the different dredges engaged on this work. While it is the intention to present methods and actual results secured rather than to discuss the design and performance of centrifugal pumps and impellers, it is thought that some comparative observations made of the different pumps will be interesting. Tests to determine certain centrifugal dredge-pump characteristics while pumping water were carefully made. The results of these tests are given in Tables 1 and 2. Observers were selected and were rehearsed several times to make sure that they understood just what was required of them. All practicable precautions were taken so that accurate results would be secured. Readings were recorded as observed, the object being to eliminate any intention to interpret or analyze readings while test was in progress. A study of the readings does not reveal any wide range in any set of readings for a given condition. All the figures in Table 1 are a mean of a number of readings and the writer has confidence in the correctness of all observation and computations, and it is believed that the data presented will be of value in analyzing and studying the design and performance of centrifugal dredging pumps. At the time tests were made, the dredges were in good operating condition, but no special preparation of machinery was made. All of the pumps tested were of the single suction type and all impellers, with one exception, were shrouded on both sides. The pumps were directly connected to vertical triple-expansion engines.

Upon the completion of the tests made on the dredges *Captain Huston* and *Dixie*, both of which were equipped with pumps

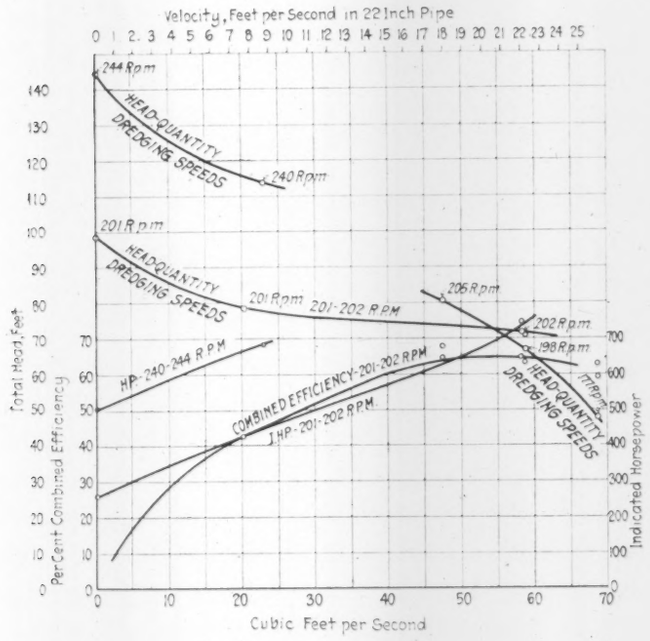

FIG. 8 CURVES OF DREDGE *Texas* EQUIPPED WITH IMPELLER DESIGNED BY A. B. WOOD

having modified propellers, it was decided to test the pumps of the dredge *Pelican*, which was fitted with an open impeller. This pump, shown in Fig. 11, was tested with impeller in the pump in the normal manner with the vanes curved backward and also with the impeller reversed,[1] i.e., with the vanes curved in the direction of rotation. The results were surprising and are shown in detail in Table 1 and the curves of Figs. 12 and 13. So far as the operation of the dredge was concerned, both while pumping water and also while dredging, there was nothing

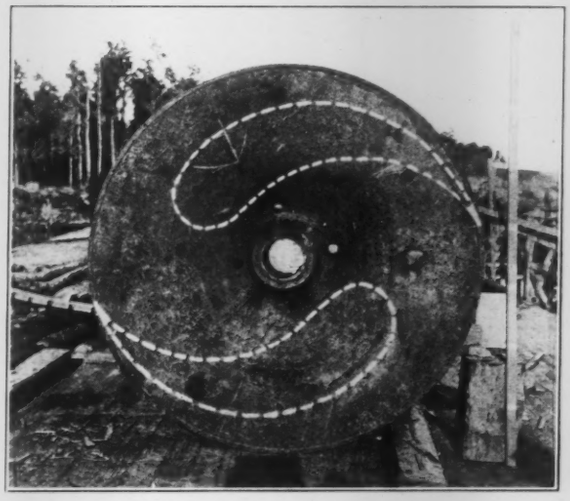

FIG. 9 REAR VIEW OF TWO-VANED IMPELLER DESIGNED BY A. B. WOOD

to indicate to the closest observer that the pump was not assembled in the usual manner. After completion of tests it was found by comparison that there was a 10 per cent loss of

FIG. 10 VIEW SHOWING THE LARGE PASSAGEWAYS OF THE IMPELLER DESIGNED BY A. B. WOOD

efficiency due to increased consumption of power with the reversed impeller. As a matter of interest it might be stated that the dredge *Pelican* was operated from June 1 to June 14, 1919, with the reversed impeller, nothing unusual being noticed in operation and no diminution in yardage being apparent.

[1] In Trans.Am.Soc.C.E. vol 50, page 505, Oct. 1905, Colonel C. W. Sturtevant, Mem.Am.Soc.C.E., mentions a centrifugal pump having been operated with impeller vanes curved forward instead of backward.

In the tests of dredges *Texas* and *Captain Huston* the quantity of water discharged by the pump was measured by pitot tube and venturi meter. While testing the dredge *Captain Huston* the pitot tube was bent and was not used in the tests of the other dredges. During tests the venturi meter was located just astern of the dredge in a straight section of pipe, where it would not be influenced by elbows. Suitable arrangements were made so that the discharge pipe could be throttled, or closed off entirely, and in this way a variation in head and quantity was created. Piezometers were ¼-in. tee-handled pet cocks, which were screwed into

which reference has already been made; one 20-in. dredge was chartered at a monthly rate for the bare dredge, all operating and maintenance costs being borne by the Board; and two 20-in. and one 22-in. dredges were chartered by the Board at a rate to include all operating and maintenance charges except fuel and shore pipe line, which were borne by the Board. In securing dredges for this work it was necessary to tow them to New Orleans from more or less distant points, two having been brought from Havana, Cuba, the Board assuming all towing charges and paying one-half the charter rate while dredges were in transit. A

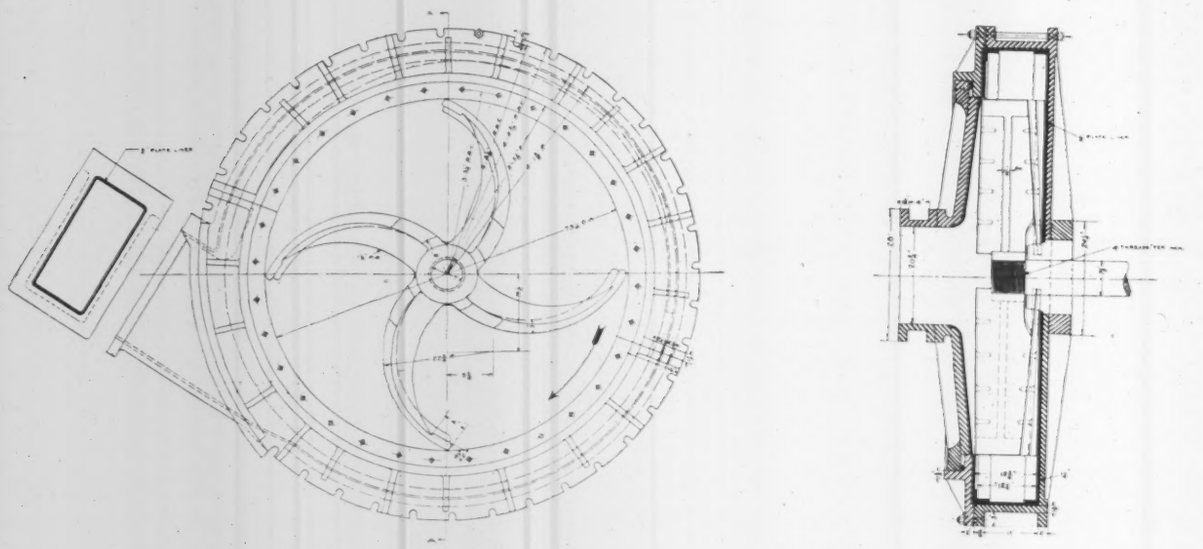

FIG. 11 DETAILS OF THE IMPELLER OF THE DREDGE *Pelican*

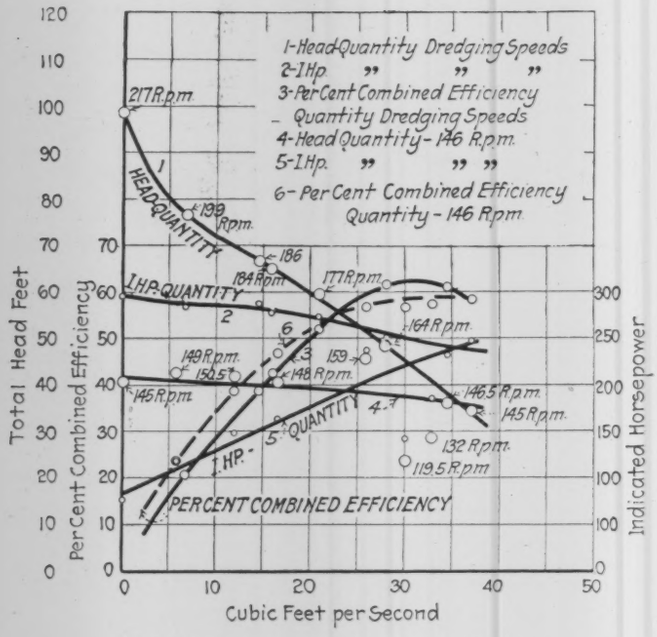

FIG. 12 TEST CURVES OF DREDGE *Pelican*

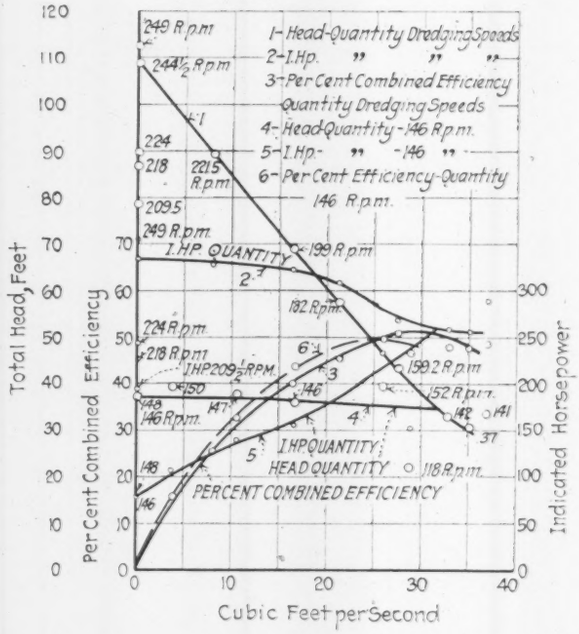

FIG. 13 TEST CURVES OF DREDGE *Pelican* WITH IMPELLER REVERSED

the pipe. Indicators were not calibrated, but are believed to have been in excellent condition. Cards were taken simultaneously on the three engine cylinders. It was unfortunate that during the drop in pressure test made on dredge *Dixie* it was impossible to obtain comparable peripheral speeds due to valve of intermediate cylinder being improperly set.

From May 15, 1918, to August 1, 1919, there were employed in the construction of the Inner Harbor-Navigation Canal four 20-in. dredges and one 22-in. dredge. One of the 20-in. dredges was owned and operated by the Board of Port Commissioners, to

careful record of costs was kept and the total yardages by months and the total and the unit costs of the same will be found in Table 3, page 80. These costs are divided under three headings:

ARBITRARY

Cost of towing to and from New Orleans

One-half rental paid while in transit

Cost of 477,193 cu. yd. of preliminary and auxiliary dredging

Cost of design and manufacture of two-vane impeller for 22-in. dredge

TABLE 1 DATA AND RESULTS OF TESTS OF CENTRIFUGAL DREDGING PUMPS

Test Number	Steam Pressure, lb. sq. in. gage.	r. p. m.	Suction, ft. of water.	Discharge, ft. of water.	Total, Including Difference of Velocity Heads.	Flow in ft. per sec. by venturi meter.	Indicated hp.	Water hp.	Combined Efficiency, Engine and Pump	Peripheral Speed, ft. per sec.
TEXAS February 14, 1919										
1	175	201	− .94[a]	76.02	77.03	20.16	423.4	175.8	41.5	70.16
2	175	201	+ .86[b]	99.34	98.48	0.0	254.45	0.0	0.0	70.16
3	173	202	−12.94	57.57	71.18	58.37	742.5	471.0	63.3	70.51
4	170	240	− 1.34[a]	112.04	113.47	22.86	681.9	293.0	43.0	83.78
5	175	244	+ .86[b]	145.29	144.43	0.0	403.4	0.0	0.0	85.18
CAPTAIN HUSTON February 23, 1919										
1	200	141	−30.20	25.82	54.26	52.38	657.9	322.1	49.0	59.06
2	198	161	−15.23	85.11	99.56	35.17	706.7	397.8	56.3	67.44
3	200	165	−12.74	93.65	105.69	33.05	729.5	396.0	54.1	69.12
4	200	166	+ .28[a]	99.89	99.61	0.0	292.7	0.0	0.0	69.54
5	191	168	−10.06	98.96	108.49	28.87	682.8	355.8	52.1	70.38
6	200	174	−10.97	104.97	115.33	30.78	742.8	403.0	54.3	72.95
7	200	182.5	− 6.56	123.67	129.88	23.47	756.8	346.0	45.7	76.48
8	200	184	− 6.40	122.22	128.27	23.47	759.6	341.7	45.0	77.00
9	200	221.5	+ .28[a]	186.94	186.66	0.0	426.0	0.0	0.0	92.78
DIXIE March 11, 1919										
1	158	158	−25.99	28.52	54.70	49.55	559.55	307.50	55.0	57.91
2	155	160	−22.98[b]	34.27	57.42	46.62	568.83	303.71	53.4	58.64
3	150	163	− 7.68	58.36	66.10	27.29	446.78	204.66	45.8	59.74
4	156	163.5	−18.48[b]	44.22	62.85	42.0	551.42	299.56	54.3	59.92
5	145	166	− 8.16	60.21	68.44	27.81	471.47	215.94	45.8	60.84
6	152	174.75	− 9.32	66.68	76.08	30.35	545.4	261.8	48.0	64.05
7	155.7	175.5	−10.74	64.71	75.54	32.33	577.42	277.25	48.0	64.32
8	154.5	176	− 2.68[a]	76.37	79.08	17.85	479.15	160.15	33.5	64.50
9	156	176	− .03	78.91	78.95	8.95	407.72	80.11	19.65	64.50
10	156	176.5	+ .92[a]	82.61	81.79	0.0	310.24	0.0	0.0	64.68
11	151	186	− 3.60	83.76	87.40	19.47	547.96	193.06	35.3	68.17
12	150	197	− .38[a]	99.46	99.85	10.21	552.39	115.66	20.95	72.20
13	154	219	+ .82[a]	127.17	126.35	0.0	578.31	0.0	0.0	80.26
PELICAN May 28, 1919										
1	174.5	119.5	+ 3.99	8.93	23.16	30.06	139.95	78.9	56.3	38.06
2	175	132	−17.40	10.58	28.26	32.90	184.33	105.2	57.2	42.04
3	175	145	−21.96	11.78	34.10	37.04	246.10	143.0	58.1	46.18
4	182.5	145	+ .88[a]	41.45	40.57	0.0	75.66	0.0	0.0	46.18
5	175	146.5	−1.95	16.63	35.90	34.58	231.32	140.3	60.7	46.66
6	180	148	− 3.87[a]	36.38	40.32	16.61	162.82	76.0	46.6	47.14
7	175	149	+ .28[a]	42.88	42.61	5.74	117.93	27.7	23.5	47.46
8	180	150.5	− 1.57[a]	40.06	41.67	11.99	147.15	56.6	38.5	47.93
9	182.5	159	−11.34	34.03	45.55	25.96	236.30	133.8	56.7	50.64
10	182.5	164	−12.91	35.03	48.14	28.01	249.94	152.8	61.2	52.23
11	182.5	177	− 7.66	51.68	59.45	20.93	272.30	140.8	51.75	56.37
12	177.5	184	− 4.0	60.61	64.69	15.97	276.22	117.0	42.4	58.60
13	175	186	− 2.82[a]	63.63	66.51	14.65	286.53	110.2	38.5	59.24
14	175	199	+ .08[a]	76.78	76.71	6.79	283.2	59.0	20.75	63.38
15	177.5	217	+ .88[a]	99.41	98.53	0.0	295.22	0.0	0.0	69.11
PELICAN May 31, 1919 During this test the runner was reversed										
1	175	118	−13.49	7.98	21.69	28.85	151.78	70.9	46.75	37.58
2	176	137	−19.67	10.53	30.52	35.1	255.12	121.3	47.6	43.63
3	189	141	−21.75	11.28	33.39	36.9	288.57	139.3	48.35	44.91
4	172.5	142	−17.53	15.08	32.89	32.85	256.88	122.3	47.7	45.23
5	177.5	146	− 3.93[a]	31.88	35.88	16.65	154.56	67.70	43.8	46.50
6	175	146	+ .88[a]	37.98	37.10	0.0	75.85	0.0	0.0	46.50
7	175.5	147	− 1.13[a]	36.68	37.84	10.60	138.93	45.5	32.7	46.82
8	172.5	148	+ .88[a]	38.18	37.30	0.0	79.48	0.0	0.0	47.14
9	172.5	150	+ .64[a]	40.08	39.44	3.76	106.66	16.78	15.73	47.78
10	181	152	−10.63	28.58	39.38	25.90	233.58	115.3	49.4	48.41
11	181	159	−11.84	31.18	43.22	27.54	266.79	134.7	40.55	50.64
12	177.5	182	− 7.14	50.18	57.44	21.38	307.91	139.0	45.2	57.97
13	187.5	199	− 3.88[a]	64.88	68.83	16.49	321.50	128.5	40.0	63.38
14	181	209.5	+ .88[a]	79.68	78.80	0.0	194.58	0.0	0.0	66.73
15	180	218	+ .88[a]	87.83	86.95	0.0	227.89	0.0	0.0	69.43
16	170	221.5	− .43	88.78	89.23	8.17	327.96	82.50	25.18	70.55
17	185	224	+ .88[a]	90.58	89.70	0.0	243.34	0.0	0.0	71.34
18	185	244.5	+ .88[a]	109.78	108.90	0.0	334.57	0.0	0.0	77.87
19	185	249	+ .88[a]	113.58	112.70	0.0	354.46	0.0	0.0	79.31

[a] Readings of suction gage incorrect because of whirl set up in pipe by pump impeller.

[b] Suction readings incorrect due either to pet cock being throttled down too much or getting temporarily choked up.

DISCHARGE-PIPE-LINE CONDITIONS FOR TESTS OF DREDGING PUMPS GIVEN IN TABLE 1

Texas: Tests 1 and 4, 8-in. valve on end of discharge pipe wide open. Tests 2 and 5, 8-in. valve on end of discharge pipe cut off. Test 3, pipe line 570 ft. pontoon and shore pipe.

Captain Huston: Test 1, Pipe full opening. Test 2, Iron plate bolted on discharge pipe. Tests 3, 7, and 8, 8-in. valve on end of discharge pipe wide open. Tests 4 and 9, 8-in. valve on end of discharge pipe cut off. Tests 5 and 6, Pipe line 3538 ft. pontoon and shore line.

Dixie: Test 1, Pipe full opening. Test 2, Wooden piece bolted on discharge pipe. Tests 3, 5, and 6, Pipe line 1583 ft. pontoon and shore pipe. Test 4, 2 pieces of wood bolted on end of discharge pipe. Test 7, Iron plate bolted on end of discharge pipe. Tests 8 and 11, 8-in. valve on end of discharge pipe wide open. Tests 9 and 12, 8-in. valve on end of discharge pipe partly closed. Tests 10 and 13, 8-in. valve on end of discharge pipe cut off.

Pelican: Tests 1, 2, and 3, Pipe full opening. Tests 4 and 15, 8-in. valve on end of discharge pipe cut off. Tests 5 and 10, Wooden piece bolted on end of discharge pipe. Tests 6 and 11, 3 wooden pieces bolted on end of discharge pipe. Tests 7 and 14, 8-in. valve on end of discharge pipe partly closed. Tests 8, 12 and 13, 8-in. valve on end of discharge pipe wide open. Test 9, 2 wooden pieces bolted on end of discharge pipe.

Pelican (with reversed runner): Tests 1, 2, and 3, Pipe full opening. Test 4, Wooden piece bolted on end of discharge pipe. Tests 5 and 12, 3 wooden pieces bolted on end of discharge pipe. Tests 6, 8, 14, 15, 17, 18 and 19, 8-in. valve on end of discharge pipe cut off. Tests 7 and 8, 8-in. valve on end of discharge pipe wide open. Tests 9 and 16, 8-in. valve on end of discharge pipe partly closed. Tests 10 and 11, 2 wooden pieces bolted on end of discharge pipe.

In all cases where length of discharge pipe is not given the length was less than 100 ft. from the stern of dredge. In general, it should be stated that the figures in Table 1 are a mean of a number of readings recorded during tests, which explains why the figures are worked out to two decimal places. The venturi meter had an inlet diameter of 22 5/16 in. and a throat diameter of 18 in. For readings at cut off, the elevation of water at rest in suction pipe was taken as suction head and for other readings of low quantity the suction head was taken from loss pressure curve plotted from high quantity readings.

TABLE 2 DATA ON CENTRIFUGAL DREDGING PUMPS

	Texas	Capt. Huston	Dixie	Pelican	Pelican†
Diam. of impeller, in.	80	96	84	73	73
Number of vanes	2	3*	3*	4	4
Diam. of suction pipe at suction gage, in.	23½	19½	20⅛	20½	20½
Diam. of discharge pipe at discharge gage, in.	22⅝	20½	20⅛	25½x12⅝	25½x12⅝
Triple expans. engine, in.	14x21½x35	14½x22½x40	14½x22½x36	11⅛x18x29	11⅛x18x29
Length of stroke, in.	18	20	18	18	18
Water at rest in canal above center-line of pump, in.	10½	3½	9½	.....	.....
Water in river above center-line of pump, in.	.....	.....	.....	10½	10½
Zero of suction gage below center-line of pump, in.	19	20	16.68	1.68	At center line of pump
Zero of discharge gage above center-line of pump, in.	20	.....	.....	7	7
Zero of discharge gage below center-line of pump, in.	.....	53⅝	47.66	.....	.....

*Originally 6, parts of 3 vanes removed. †This test made with impeller reversed.

CHARTER

Charter cost of four dredges

ALL OTHER CHARGES

Fuel

Shore pipe lines

Labor, subsistence, repairs, material, insurance and supervision.

The writer was present and assisted in the very complete test of hydraulic dredges made for the Mississippi River Commission

(*Continued on page* 80)

Thermal Conductivity of Insulating Materials

By T. S. TAYLOR,[1] EAST PITTSBURGH, PA.

Despite the fact that numerous thermal-conductivity measurements have been made, but very few data are available for such materials as are used in the construction of electrical machinery. To further investigate this field the author accordingly conducted a series of tests based upon two methods, both of which are explained in detail in this paper. The results obtained are tabulated in the complete paper for such materials as fish paper, fuller board, cambric, mica tape, various kinds of woods, asbestos, plate glass, sheet steel, wool felt, etc., and a selection covering various miscellaneous materials is given in the present abstract.

ALTHOUGH numerous experimenters have been interested in making thermal-conductivity measurements, but very few data are available for such materials as are used in the construction of electrical machinery. The most important work on such insulating materials thus far available was done by Symons and Walker,[2] but the materials tested by these authors were special and consequently the values obtained cannot be taken as applicable to similar materials used in the construction of electrical machinery in this country. The investigations herein described were therefore undertaken to obtain values of the thermal conductivity of insulating and other materials, the values of which are of direct interest to those concerned with the heat problem in electrical apparatus. Results have also been obtained for numerous other materials of general interest.

The Northrup Thermal Bridge

As a preliminary step it seemed worth while to try the "Thermal Bridge" method suggested by Prof. E. F. Northrup.[3] The bridge used is shown in Fig. 1. It consisted of two soapstone cylinders each 4⅝ in. in diameter, one being 8½ in. long and the other 3 in. long. Each cylinder consisted of an inner core 1⅝ in. in diameter surrounded by a concentric cylinder having a wall thickness of 1⅜ in. The two faces along *MN* separating the two parts of the apparatus were ground so as to fit very closely. A spiral groove was cut in the top of the longer cylinder *E* and a heater wire placed in this groove. Small holes, 1, 2, 3, etc., were drilled at right angles to the axis of the cylinders through the outer wall and into the central core as indicated. Copper-constantan thermocouples made of 0.005-in. wire were inserted in these holes for the purpose of determining the temperature gradient along the cylinders. The lower part of the apparatus *F* was placed on a brass box which served as a cold-temperature reservoir when kept filled with water and ice or when the water was kept circulating through it. The heat generated at the top would flow down the core and outer wall through the junction *MN* to the reservoir. The purpose of the core and surrounding wall was to insure a uniform flow of heat through the core. Felt was placed around the outer cylinder to further prevent undue loss of heat from the surface of the apparatus.

If the distance from thermocouple 1 to thermocouple 5 is made the same as that from 2 to 8, and the conditions are such that a uniform temperature drop exists along the core, the thermal conductivity of a material placed in *MN* can be determined in terms of soapstone. First suppose the above conditions to exist when there is no specimen in *MN*. Then the temperature drop will be uniform along the apparatus, as can be tested by the thermocouples. When a sample is inserted in *MN* and the temperatures of 1, 5, 2 and 8 are measured, the drop between 2 and 8 exceeds that from 1 to 5 by an amount equal to the drop through the sample. The soapstone equivalent of the sample is then readily calculated from the temperature drop through the sample and the drop per unit length along the soapstone.

[In the actual experiment, described by the author in his complete paper, the procedure was slightly different from that outlined above, from the fact that the distance from thermocouple 1 to 5 was not exactly the same as from 2 to 8. The use of the thermal bridge, however, proved to be unsuited to the work, for a series of tests gave results that varied considerably. Another method was therefore employed in which use was made of a "thermal meter." A description of this method follows.—Editor.]

The "Thermal Meter"

A sketch of the "thermal meter" used is shown in Fig. 2. It consisted essentially of an electric heater *H* constituting two hot

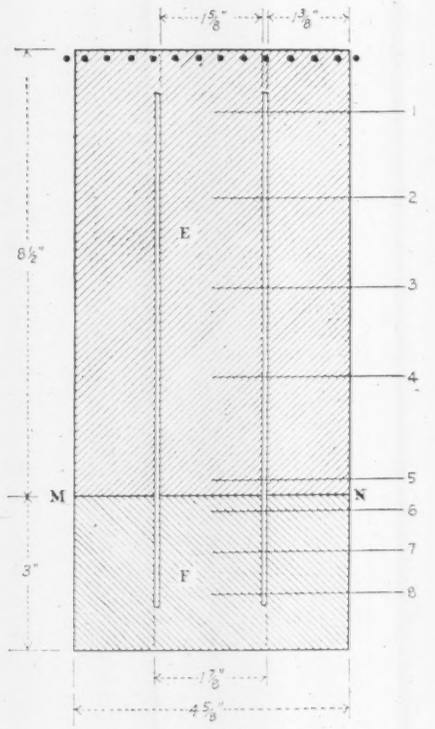

Fig. 1 Diagrammatic Sketch of the Northrup Thermal Bridge

equitemperature surfaces or sources of heat and two cooling chambers *E*, *E* (one on either side of the heater) or cold constant-temperature surfaces. The heat generated in *H* passed laterally through the samples *I*, *I*, of a given material to the cold reservoirs *E*, *E*. The heater was made from two disks of soapstone 9 in. in diameter and ⅜ in. thick. Each disk had a spiral groove of 3/16-in. pitch cut in one face. A heater wire, No. 21 constantan, was wound and cemented securely in the groove of each disk and then the iron disks were cemented together with the sides containing the heater wire adjacent. The two heating elements in the two disks were joined together at the center by means of a peg in one disk being pushed into the spring contact in the other. Potential leads were brought out from each heating element at points 2 in. from the centers. It was later found that potential leads fastened to the heating elements at the points

[1] Westinghouse Research Laboratory, Westinghouse Electric and Manufacturing Company.

[2] See Journal of the Institute of Electrical Engineers (London), vol. 48, p. 674, 1912.

[3] See American Electrochemical Society Journal, no. 24

Abstract of a paper presented at the annual meeting, New York, December 1919, of The American Society of Mechanical Engineers. All papers are subject to revision.

where the wire started in the outer terminals of the spirals served equally well, since the temperature coefficient of resistance of the constantan wire is very small and furthermore the temperature of the heater was constant over its entire face. Extra turns of wire were wound around the outer edge of the heater in order to prevent the loss of the heat generated in the heating element proper through the edge of the heater. After several trials it was found that this procedure gave a heater which in use had a very constant temperature over its two faces, even up to the outer edge.

Two samples of the material to be tested were always used, each being 9 in. in diameter and from 0.1 to 0.75 in. thick, depending upon the nature of the material. One sample was placed on each side of the heater *I, I,* Fig. 2. Extra disks of lagging of the same material of the sample or something else suitable were placed on each side of the sample, as shown by the shaded portions in Fig. 2. This made the ultimate drop at high temperatures less than it otherwise would have been, and likewise gave a wider range of mean temperature. The faces of the cold reservoirs *E, E,* constituting the cold equitemperature surfaces, were made of heavy brass having a diameter of 10 in. The samples, heaters, and cold reservoirs were held securely together by means of bolts extending between these two plates. At first strong spiral springs were used around these connecting bolts to insure uniform pressure, but it was found later that equally satisfactory results could be obtained by merely turning down the nuts on

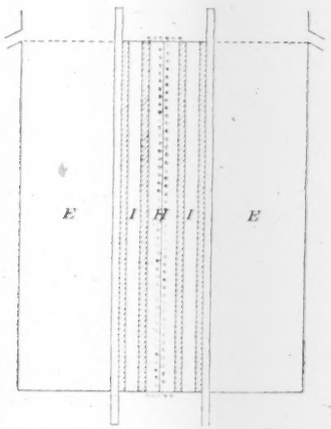

FIG. 2 DIAGRAMMATIC SKETCH OF THE THERMAL METER

the bolts till the samples, etc., were drawn tightly together. Thermocouples of 5-mm. copper-constantan wire were inserted on each side of the samples *I, I,* under test. Great care was taken in order to insure good contact between the sample and the thermocouple junction. Two couples were placed on each side of a sample, one at the mid-point and another about 1½ in. from the center. The electromotive force of the couples (the cold junction being always kept at 0 deg. cent.) was measured by means of a thermocouple potentiometer. The current in the heater was likewise measured by the same potentiometer by measuring the drop through a standard resistance placed in series with the heater. The potential drop per unit length of heater wire was also measured by means of the potentiometer. This necessitated placing a high resistance in parallel with the heater and then measuring the potential drop across a small fraction of this. The current was supplied by a storage battery and consequently remained quite steady. The cold equitemperature surfaces *E, E,* were maintained so by having water from the tap circulating through them continuously. The outer edges of the samples and heater were surrounded by felt in order to prevent undue loss of heat from the edges of the heater and samples.

In order to facilitate the work a second apparatus having the same parts as the one described above was constructed. The only difference being that the heater, etc., were of square cross-section. This heater was made of soapstone slabs 12 in. square. The heater wire (No. 21 constantan) was wound back and forth in parallel slots 3/16 in. apart in each of the parts of the heater This made its construction quite easy. The elements of the two parts of this heater were joined in parallel as its resistance would have been too high for the available voltage had they been in series. The potential leads of this heater were joined at the ends of a wire in a single groove, thus measuring the drop in a 12-in. length of the wire. Four sets of potential leads were inserted (two in each half) and the average of the four potential drops used in calculating the drop per unit length of heater wire. As for the round heater, extra turns of wire were put around its outer edges to insure a uniform temperature source. Great care was taken to have the same amount of resistance in each element of the heater, since they were joined in parallel. The faces of the cooling reservoirs were of cast brass 13½ in. by 13½ in. by 1 in., and being heavy they did not buckle when bolted together over the heater and the materials tested. Identical results were obtained with the two pieces of apparatus for a given material.

The samples of the materials tested were usually composed of one or more sheets. Extreme care was taken to eliminate the air between the surfaces of the component sheets as much as possible by the use of vaseline, shellac, carpenter's glue, etc. By the use of such materials the drop between component sheets was made quite negligible or at least of the same order of magnitude as the drop through the same distance in the material itself. This was due to the fact that the thermal conductivity of such materials as glue, etc., when dried differs but little in order of magnitude from that of the sheet materials dealt with. In making up a sample that material was used to make good contact between the components which lent itself most readily to the case in question.

RESULTS OBTAINED BY THE THERMAL METER

Table 1 shows a typical set of results for samples made up of 7 sheets of 0.03-in. fuller board, 0.23 in. in thickness. By plotting the values of the mean temperatures as ordinates and the corresponding values of the thermal conductivity k as abscissæ it is possible to get a measure of the temperature coefficients of thermal conductivity. The values given in Table 2 if plotted will give a straight line whose equation is

$$k_t = k_o\ (1 - at)$$

where k_t and k_o are the thermal conductiveness at temperatures t and 0, respectively, and a is the temperature coefficient. From the data given the value of a for this sample is found to be about 0.0030.

In the manner thus outlined thermal-conductivity measurements have been made for a large number of materials. The values obtained are recorded in Table 3 of the complete paper and values pertaining to various miscellaneous materials will be

TABLE 1 THERMAL CONDUCTIVITY OF FULLER BOARD

Hot-side temp., t_2, deg. cent.	Cold-side temp., deg. cent.	Mean temp. deg. cent.	Conductivity k, watts, per in. per deg. cent. per sec.
29.15	18.10	23.62	0.00414
47.10	29.40	38.25	0.00432
59.45	37.15	48.30	0.00433
84.00	53.07	68.54	0.00458
102.60	65.05	83.82	0.00484
26.85	16.15	21.50	0.00407
40.87	24.20	32.54	0.00418
62.65	37.75	50.20	0.00436
115.20	70.30	92.75	0.00486

found in Table 2 of this abstract. The results in both tables are expressed both in calories per cm. per deg. cent. per sec. and in watts per in. per deg. cent. per sec. The values are also given for a definite temperature such as 20 deg. cent. as well as for an average range 20 deg. to 80 deg. The temperature coefficient is also recorded as determined in the previous paragraph. It is to be observed that all samples did not show a temperature coefficient. This is doubtless due to the changing characteristics

of the samples. Thus it is highly possible that the increase in the thermal conductivity due to an increase in temperature is counteracted by a corresponding increase in the thermal resistance due to the change in the surface contacts and likewise increase in air pockets. Besides measuring the thermal conductivity transversely for sheet material, measurements have been made as shown by Table 2 of the longitudinal conductivity along the laminations. The samples for this latter work were prepared for the one apparatus by winding up disks of the material 9 in.

TABLE 2 THERMAL CONDUCTIVITIES

Material, thickness, inches	Thickness of sample, inches	Sp. gr.	Temp., deg. cent.	Cal. per cm. per deg. cent. per sec. $\times 10^{-6}$	Watts per in. per deg. cent. per sec. $\times 10^{-5}$	Temp. coef. $\times 10^{-4}$
HARD RUBBER[1]	0.380	1.19	25-50	380	404	
WHITE FIBER[1]	0.383	1.22	20	663	705	
			20-80	695	728	12
WOODS						
White Pine[3]	0.519	0.45	20-120	255	271	
White Pine[4]	0.732	0.45	30-80	613	652	
White Oak[3]	0.516	0.60	20-80	455	484	18
White Oak[4]	0.754	0.60	40-70	944	1003	
Maple[4]	0.733	0.72	20	1015	1078	
	0.733	0.72	20-80	1037	1100	8
Maple[3]	0.508	0.72	20-80	434	462	
ASBESTOS						
$\frac{1}{8}$ in. Sheet[1]	0.344	0.894	22-80	395	420	
0.025 in. Paper[1]	0.306	0.98	20	345	367	
0.035[1]	0.356		20-100	375	399	24
			20	666	708	
			20-80	685	728	14
ASBESTOS BOARD[1]	0.507	1.93	20	1780	1890	
			20-90	1950	2080	14
PLATE GLASS[1]	0.252	2.49	20	1785	1900	
			20-100	1945	2070	18
	0.289	2.60	20	1905	2024	
	0.289		20-120	2016	2142	12
SOAPSTONE	0.715	2.87	70-120	8000	8500	
SIL-O-CEL						
Brick[1]	0.977	0.495	30	242	258	15
			30-150	262	279	
Powdered	0.955	0.15	30	208	222	31
			30-150	242	258	
WOOL FELT						
Dark Grey[1]	0.98	0.15	40	149	159	76
			40-100	175	186	
GRAPHITE						
Solid	1.04	1.58	50	105500	112200	12
			50-130	110200	117200	
Powdered, through 20 mesh on 40 mesh	0.476	0.70	40	2850	3030	
			40-100	3200	3400	48
Powdered, through 40 mesh	0.476	0.42	40	922	980	
			40-100	1007	1080	40
Powdered, through 100 mesh	0.476	0.48	40	438	467	
			40-100	482	513	34
LAMP BLACK						
Eagle Brand	0.476	0.165	40	156	160	
Germantown			40-150	166	176	6
			30	265	282	
COAL DUST	0.476	0.73	30-150	298	317	23
IRON DUST AND SAND	0.377	1.14	30	460	489	23
			30-150	517	550	
SHEET STEEL						
0.0172 in M. A.	0.415	.....	20	1370	1455	19
Varnished[1]			20-80	1430	1520	6
	1.48	.....	40-100	103000	109500	
Unvarnished[2]			40	101300	107700	
With Asphalt Paint on Sheets[2]	0.420	.....	20	4710	5020	10
			20-80	4850	5160	
Unvarnished[1] 0.0172 in.	0.416	.....	40	1480	1570	25
			40-100	1580	1680	
Same with Asphalt Paint[1]	0.425	.....	40	6360	6750	9
			40-100	6520	6930	
W. A. SILICON STEEL						
0.014 in.	0.419	.....	40-80	1270	1350	16
Varnished[1]						
	1.44	.....	40-100	41800	44400	19
Unvarnished[2]			40	39500	42000	
Same Painted with Asphaltum[2]	0.422	.....	40-80	4640	4920	10
Unvarnished[2]	0.440	.....	20	1340	1420	
	.....	.....	20-100	1470	1560	25
Same painted as above[2]	0.443	.....	20	4200	4470	
			20-100	4520	4810	17

[1]Direction of head flow transverse.
[2]Direction of head flow longitudinal.
[3]Direction of head flow across grain.
[4]Direction of head flow along grain.

in diameter, and for the other apparatus by cutting the material into strips and then forcing them tightly together in a special press. By coating the edges of the strips while in the press with glue they could be held together in a square sample and later placed in the apparatus. It is interesting to note that the ratio of the longitudinal to the transverse conductivity is much greater for the mica combinations than for the other insulating materials. This is due to the influence of the mica, whose longitudinal conductivity is so much better than its transverse. The same ratio has its least value for such materials as varnished cambric and black bias cloth. For these materials there is less difference between the transverse and longitudinal construction than the mica compounds.

Results were also obtained for the transverse thermal conductivity of 0.0172-in. carbon sheet steel and for 0.014-in. silicon sheet steel. The values obtained are slightly greater than those obtained by other observers for similar materials. Attempts were made to detect the change of transverse thermal conductivity of iron stampings with pressure, but the apparatus did not lend itself readily to this since the exact pressure applied could not be determined. Since this work has been done a testing machine has become available and a study will be made in the near future of the influence of pressure on the transverse thermal conductivity of iron stampings, and this work will be reported later. It is interesting to note that the transverse conductivity of iron stampings can be increased some 3 to 4½ times by coating the sheets with asphalt paint before putting them together. Consequently if the punchings in electrical apparatus could be assembled in groups, having a gum or other suitable material between the constituents so as to have better contact, the heat generated could be much more readily conducted away. This will also be investigated when the work on iron stampings is resumed.

Summary of Results

Experiments in the thermal conductivity of insulating and other materials have led to the following conclusions:

a The "thermal bridge" recommended by Professor Northrup has not been found satisfactory for determining the thermal conductivity of sheet materials

b Two "thermal meters," one of circular cross-section and the other of square cross-section, have been found entirely reliable for the measurement of the thermal conductivity of sheet and other materials

c By putting vaseline, glycerine, glue, shellac or a similar material on the division between two surfaces the thermal drop due to such division can be largely eliminated. This is particularly true for poor conductors

d The thermal conductivity has been measured for a large number of materials both across and along the laminations. For the poor conductors the ratio of the longitudinal to the transverse conductivity varies from 2 for black bias cloth to 5½ for mica tape

e The temperature coefficient of thermal conductivity has been measured whenever the experimental results justified.

f Of the electrical insulating materials tested, those containing mica have in general the better thermal conductivity

g As a thermal insulator soft pine is the best of the woods tested and is but little inferior to dark-grey felt.

h The transverse conductivity of iron stampings can be increased some three or four times by the insertion of some suitable material between the stampings so as to make better thermal contact. This is for a pressure of about 50 lb. per sq. in. Nothing, however, destroying the electrical insulation could be used. By using something between sheets the ratio of the longitudinal to transverse conductivity could be reduced to 20 to 25 instead of 80 to 100

i In general the thermal conductivity of laminated products can be considerably increased by suitable impregnation so as to get rid of the air film

j Oil-soaking soft fuller board increases its thermal conductivity by about 50 per cent.

k The best thermal insulation for a given thickness should be made up from several thin sheets rather than from a single sheet. This effect is more pronounced the better the conductor.

l Results were obtained for longitudinal conductivity of iron stampings. 0.0172-in carbon sheet steel is about two and one-half times better than 0.014-in. silicon sheet steel. Carbon sheet steel has a longitudinal thermal conductivity about 80 times the transverse while silicon has but 32 times the transverse.

Friction and Spreading Forces in Rolling Mills

Description of Apparatus Designed for a Special Series of Investigations to be Made on the Experimental Rolling Mill at the Carnegie Institute of Technology

By W. B. SKINKLE,[1] PITTSBURGH, PA.

In Mechanical Engineering for May, 1919, announcement was made of the decision of the officials of a number of leading steel works and firms building rolling-mill machinery to organize a Bureau of Rolling Mill Research and to install at the Carnegie Institute of Technology, Pittsburgh, for research purposes, an experimental rolling mill. This undertaking on so large and important a scale marks a distinct advance in coöperative research among manufacturers in this country. The present article by the director of the Bureau of Rolling Mill Research outlines the further development of these plans and in particular describes the equipment which has been designed for a special series of investigations on friction losses and spreading forces in rolls and roll housings as met in the actual operation of rolling mills. A feature of this apparatus is the use of what are practically frictionless support cylinders for measuring the forces acting, which provide hydraulic support in combination with the elements of a pressure gage.

THE need of accurate knowledge of the forces acting on rolls and the friction losses on roll necks in different types of rolling mills has prompted the author to respond to the editor's request for an article, with a description of a device soon to be tried out on the experimental mills of the Bureau of Rolling Mill Research at the Carnegie Institute of Technology.

By means of this equipment it is expected that experimental data will be secured which will give positive, accurate knowledge, not only of the relative values of the various lubricants and bearing metals used on roll necks, but also of the spreading forces acting on the rolls; from which the stresses in rolls and housings may be calculated to a far greater degree of accuracy than is at present possible.

The device consists of two hydraulic supporting cylinders marked Cylinder No. 1 and Cylinder No. 2 in Figs. 1 and 2, located in the bottom of the roll-housing window and so arranged that they can easily be removed and replaced by a filler.

The carrier for the bottom roll rests on the plungers of these cylinders in such a manner that the forces acting on the roll neck are recorded by the resulting hydrostatic pressure in these cylinders.

In Fig. 1 is a diagram showing the arrangement of these cylinders and their relation to the rolls. A bloom is shown between the upper and lower rolls with the lower roll carrier and cylinders. The full lines indicate the position of this carrier under static conditions (condition of rest). The conditions existing at the neck of the lower roll are greatly exaggerated for the purpose of illustration.

The total spreading force F, due to the bloom being pinched between the rolls, will cause a heavy force P to be applied[1] about as indicated in Figs. 1 and 2. Under static conditions this force would be transmitted from the body to the neck and would be applied to the bearing as indicated by the arrow A in Fig. 1. Such an application of forces would cause one half the load P on each bearing to be carried by cylinder No. 1 and the other half by cylinder No. 2.

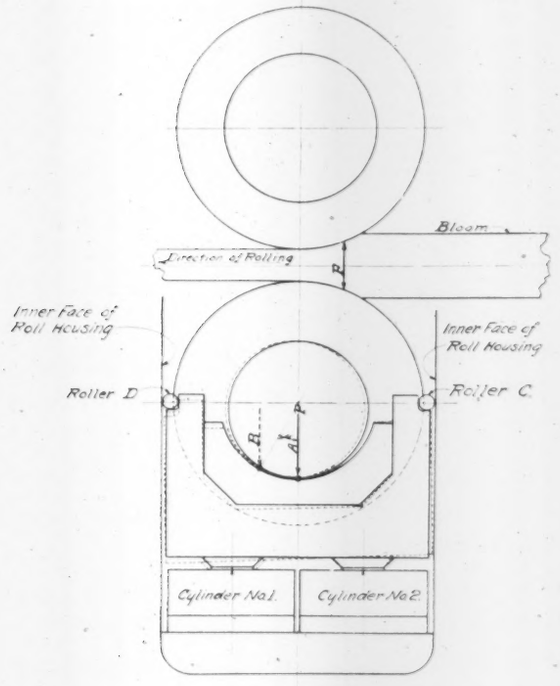

FIG. 1 ARRANGEMENT OF CYLINDERS AND THEIR RELATION TO THE ROLLS

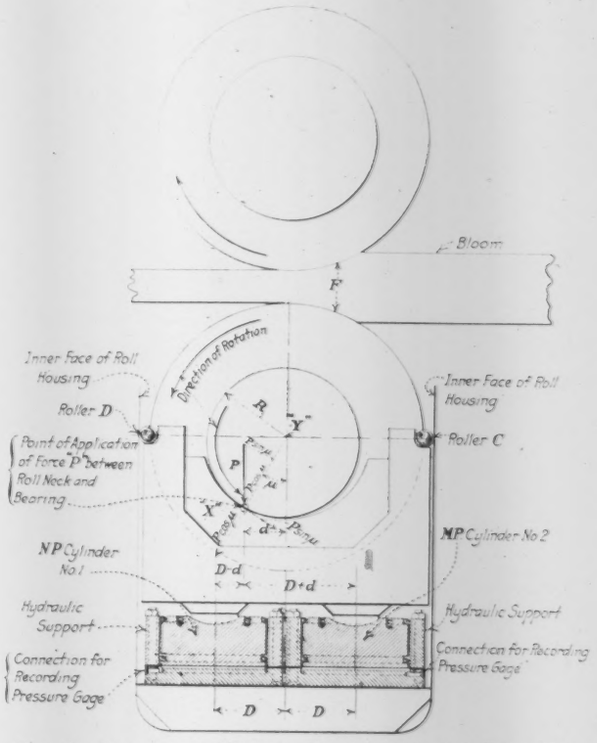

FIG. 2 DIAGRAM OF FORCES EXERTED DURING ROTATION

[1] Director, Bureau of Rolling Mill Research, Carnegie Institute of Technology. Mem. Am. Soc. M. E.

This article was prepared for *Blast Furnace and Steel Plant* and is here published through the courtesy of that journal and of the author.

[1] It is not the purpose of this article to enter into a discussion of the complicated system of forces acting at the contact surfaces between rolls and bloom. Inasmuch as the rolls are able to move up or down and are restrained from horizontal movements in any direction by the bearings and roll housing, the resultant of all forces acting must be in a vertical direction.

The proportion of the total force F which is distributed to each neck of the rolls will depend on the location of the pass in the roll body and can readily be figured by the well-known principles of beam reactions.

Where rotation starts, and the bloom is being rolled, the point of contact between roll neck and bearing changes to some other point, the force P is then applied to the bearing as indicated by the dotted arrow B, and the lower roll carrier has a tendency to assume a position indicated by the dotted lines, using the roller C as a fulcrum point; the roller D lifting off its seat. The position indicated by these dotted lines in Fig. 1 of course is greatly exaggerated for the purpose of illustration. It is vitally important, however, that the bearing be perfectly free to rotate as indicated, and that no forces other than cylinders Nos. 1 and 2 be interposed to prevent this rotating tendency. (In actual practice it is expected that not more than 0.003 in. or 0.004 in. of movement will be obtained on these cylinders between no load and their maximum carrying capacity of 250,000 lb. each.)

When the contact point has moved to a place where it slides

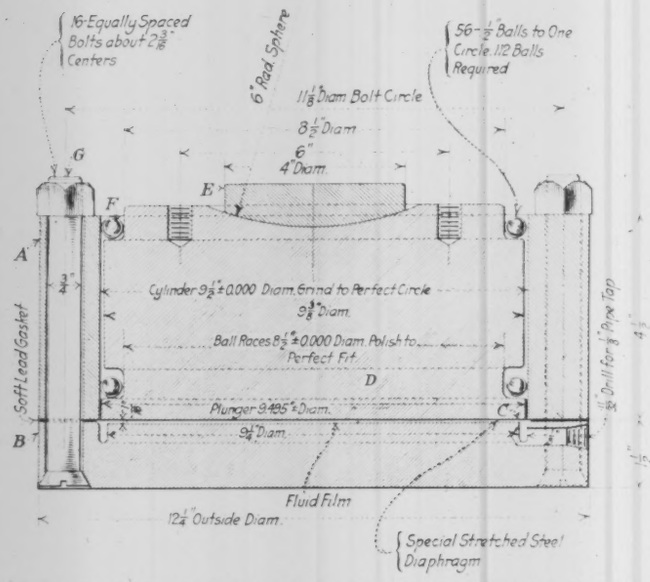

FIG. 3 DETAILS OF FRICTIONLESS HYDRAULIC SUPPORT CYLINDER

back as rapidly as it tends to climb, the angle of sliding friction has been reached and a condition of equilibrium is again established.

These conditions are shown and analyzed in Fig. 2. The pressures on the supporting cylinders will no longer be equally distributed, as in the case of static conditions, but will be much heavier on cylinder No. 1 than on cylinder No. 2.

In the analysis of these conditions the following symbols will be used:

P = Total resultant force on the roll necks in pounds.
R = Radius of the roll neck in inches.
U = The angle whose tangent is the coefficient of friction.
D = Distance from center line of roll housing to center line of supporting cylinder.
d = Distance from center line of roll-neck bearing to the point of contact between the neck and bearing.
N = Some fraction of P greater than $\frac{1}{2}$.
M = Some fraction of P less than $\frac{1}{2}$.

If equilibrium in a "free body" is maintained the following conditions must be met:

1 The sum of all horizontal or vertical forces acting on the body must be equal to zero.

2 The sum of the moments of all forces acting on the body taken about any point must equal zero.

Fulfilling the first condition, as applied to the vertical forces on the lower roll-neck bearing, we have $-P + N\,P + M\,P = 0$, whence $N\,P + M\,P = P$. Canceling the P's we have

$$N + M = 1$$

This shows that for each increase of over half the total load carried by cylinder No. 1 there is a corresponding decrease in the load carried by cylinder No. 2 and that the sum of the pressures on cylinders Nos. 1 and 2 must be equal to the force P. This same fact can be shown by taking moments about the point x where the roll neck applies its load to the bearing. In this case the force P has no lever arm. Its moment would therefore be zero, and it may be neglected. Taking moments about x we have

$$+ N\,P\,(D - d) - M\,P\,(D + d) = 0$$

which expands into

$$N\,P\,D - N\,P\,d - M\,P\,D - M\,P\,d = 0 \ldots\ldots\ldots [1]$$

Taking moments about Y the center of the roll neck we have

$$-P\,d + N\,P\,D - M\,P\,D = 0 \ldots\ldots\ldots\ldots [2]$$

The foregoing is true only if the hydraulic support cylinders are *frictionless*. If these hydraulic cylinders were of the ordinary hemp-packed plunger type the results obtained would be almost useless as the friction of the packing on the plunger would be very large and the exact amount of this friction would be very difficult if not impossible to determine.

It will therefore be necessary to produce a frictionless hydraulic support cylinder. This, the author believes, has been practically obtained in the cylinder shown in Fig. 3. While it is recognized that no machine can be absolutely frictionless, this cylinder so nearly approaches this ideal state that for all practical purposes it may be considered as frictionless.

The cylinder consists of an upper guide cylinder A securely bolted to its base B by sixteen $\frac{3}{4}$-in. bolts G. The base, which is really the cylinder proper, has a groove $9\frac{1}{4}$ in. inside diameter cut into it. The center portion of the base is then faced off to allow just a film of fluid not over $\frac{1}{16}$ in. in thickness to act on a special stretched-steel diaphragm C which is securely held in place by the friction between the parts A and B of the cylinder and is made tight on its lower side by a soft lead gasket. By this means the fluid is completely confined in the cylinder, the only escape being through the orifice leading to the recording pressure gage. The plunger D does not come in contact with the fluid in the cylinder but rests on the upper side of the steel diaphragm C. These contacting surfaces must be very flat and true.

In order to avoid friction between the plunger D and the side walls of the guide cylinder A the plunger is turned $\frac{1}{8}$ in. smaller in diameter than the guide cylinder on its upper parts, and 0.005 in. smaller in diameter where it rests on the diaphragm.

In order to prevent lost motion, or the plunger from tilting and shearing the diaphragm, and further to prevent the plunger from getting "off center" and having a rubbing contact with the cylinder walls, two rings of fifty-six $\frac{1}{2}$-in. diameter steels balls each, marked F, are provided.

The inside diameter of the guide cylinder A is ground to as nearly a perfect circle as possible and the grooves for the balls are ground and polished to an accurate fit.

When the plunger moves downward due to the application of a load these steel balls tend to lift off their seats and establish a rolling contact between the plunger and cylinder walls.

The only friction on this cylinder is the friction of these ball bearings, the internal friction of the steel in the diaphragm and the friction of the fluid in the pipes leading to their recording gages. These quantities are so small when compared with the maximum load of 250,000 lb. which each cylinder is designed to carry, that they may be neglected.

The displacement of fluid by the plunger when under load is equally small. Marks' Mechanical Engineers' Handbook, page 251, gives the following information: "A pressure of 1 lb. per sq. in. compresses liquids in volume as follows: Water 1 part in 300,000; mercury 1 part in about 4,700,000. For water in an iron pipe this corresponds to a compression of 2 in. per mile of length for a pressure of 10 lb. per sq. in."

It will easily be seen that such a compression of the fluid will not disturb the roll setting. The only other factors entering into the plunger displacement are the quantity of fluid necessary to move the needles of the recording gages and the expansion of

the short pipes leading to these gages. Both of these factors are so small that they may be neglected.

The idea of this frictionless diaphragm cylinder is not new, but has had several stages in its development. It appears to have been originally invented by Mr. Emery, who first applied it to the well-known testing machine bearing his name. The general application of this invention was delayed by the fact that Mr. Emery measured the pressure in his hydraulic supports by means of a complicated balancing and weighing mechanism. The hydraulic support was made accessible to general use by the research work of Dr. A. Martens at the German Government materials-testing station, who measured the pressure in the hydraulic

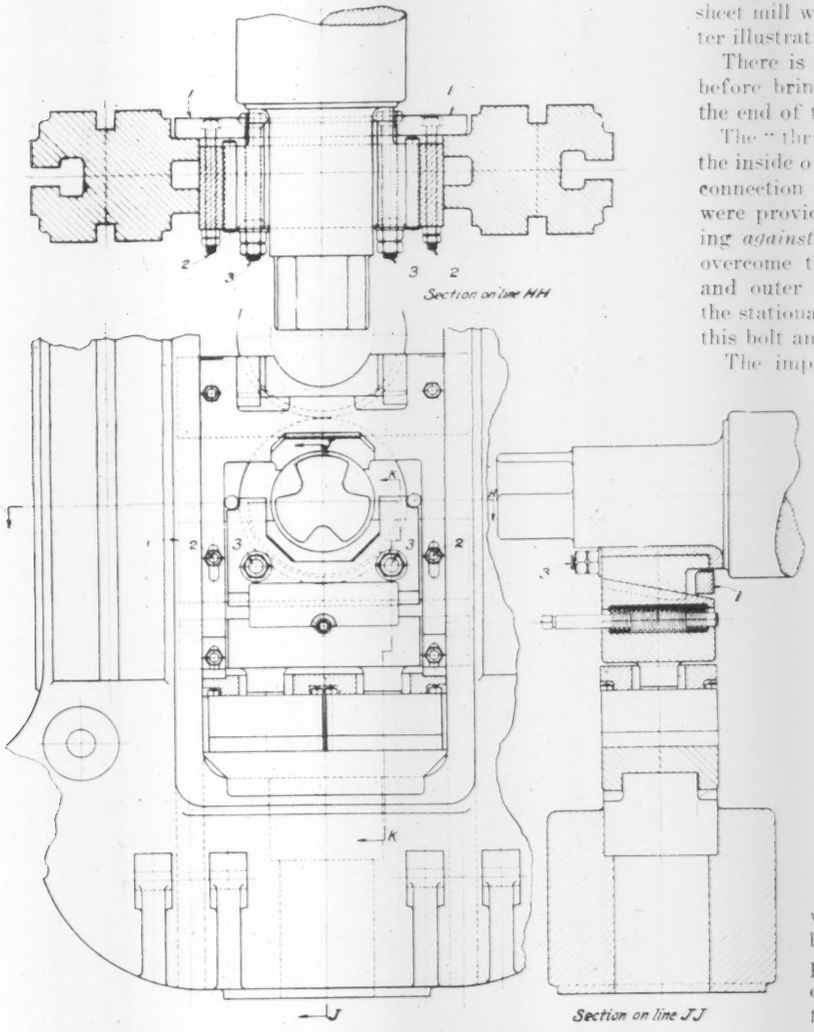

FIG. 4 DETAILS OF MILL SHOWING BOLT WITH "BALL JOINT" TO PROVIDE FLEXIBLE CONNECTION BETWEEN THRUST PLATE AND LOWER ROLL CARRIER.

support by means of Bourdon pressure gages and who proved conclusively that the combination of hydraulic support and pressure gages forms the most accurate and desirable means for measuring without friction or lost motion, forces of any magnitude and of any suddenness of application.

Prof. W. Trinks, head of the department of mechanical engineering at the Carnegie Institute of Technology, first conceived the idea of applying cylinders of this type to roll necks sometime early in 1916, and made drawings of a special roll housing for this purpose.

When the author was placed in charge of the organization of the Bureau of Rolling Mill Research and of the designs of the experimental mill he carried the development one step further by designing the present cylinders in such a manner that they would fit in the window of an ordinary roll or pinion housing, and could easily be replaced by a filler casting in case experiments not requiring their use were to be made.

The first cylinder of this type is now in the course of construction and will be carefully tested and calibrated under a 600,000-lb. compression testing machine before the final design is produced for the experimental mill.

Diaphragms varying in thickness from 1-64 in. to 3-64 in. are on hand and their relative merits together with the relative merits of mercury or water for the fluid will be carefully investigated before the final selections are made.

Fig. 4 shows these cylinders applied to the 18-in. three-high bar mill, which are somewhat different from those shown in Figs. 1 and 2. These last-mentioned figures were taken from the 24-in. sheet mill with the neck brass "faked in" for the purpose of better illustration of the mechanical principles involved.

There is one more important item which should be considered before bringing this article to a close. That is the friction of the end of the roll-neck brass on the roll body.

The "thrust plate" marked "1" in Fig. 4 is held firmly against the inside of the roll housing by bolts 2 and 3 and, unless a flexible connection between the lower roll carrier and this thrust plate were provided, would offer a very substantial resisting force acting *against* the rotating tendency of the lower roll carrier. To overcome this bolts 3 are made with ball joints at their inner and outer ends. In this manner any retarding action due to the stationary thrust plate is avoided. Fig. 5 is a section through this bolt and clearly shows the construction.

The importance of careful experiments on roll-neck friction

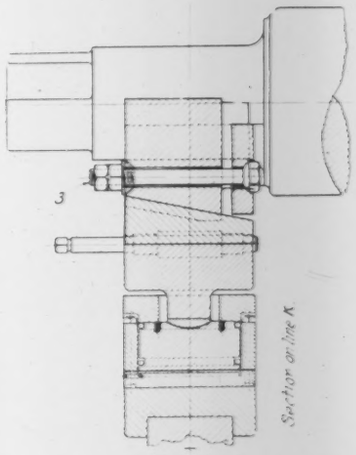

FIG. 5 DETAILS OF BOLT SHOWN IN FIG. 4

will be realized when it is stated that, according to the best information at present available, between 40 and 50 per cent of the total work of a blooming or bar-mill engine is absorbed in friction on the roll necks. These figures represent the best working conditions in rolling-mill practice. For mills such as plate, skelp or sheet mills rolling wide, thin sections, which are often cold, the work lost in friction on the roll necks is frequently between 70 per cent and 80 per cent of the total work of the engine or motor.

The designs of the experimental mills are being worked out with extreme care, which of necessity involves a slow rate of progress. They offer a great many problems similar to the one just described. It is expected that these designs will be completed some time during the next three or four months and will be given to the public very shortly thereafter.

The Carnegie Institute of Technology is throwing open to members of the Bureau nearly $400,000 worth of building and equipment, free of all charges for rentals, etc. More than half the money necessary to add this experimental rolling mill has already been definitely subscribed and the remainder is in sight. The completion of this experimental mill will make the Bureau of Rolling Mill Research what is probably the largest and most complete steel research laboratory in the world.

Steam Use in Textile Processes

By GEORGE H. PERKINS,[1] BOSTON, MASS.

The following paper, presented at the Textile Session of the Annual Meeting of the A.S.M.E., and here given nearly in full, presents tables of comparative figures showing the importance of the use of steam for the manufacturing processes in the textile industry.

Analyses are given of the various uses to which steam is put and suggestions are made for research and improvement of economy.

THE collective textile industries of the United States consume 9,662,600 tons of coal annually and require for their operation a total primary power of 2,495,000 hp. of which 66.8 per cent, or 1,665,900 hp., is developed by steam prime movers.

Tables 1 and 2 give figures compiled from the United States Census of Manufactures for 1914, showing the distribution of coal and primary power to the seven principal manufacturing groups included in the textile industry. These figures serve to emphasize the magnitude of the steam requirements of this industry, which are to be considered in this paper with particular reference to the heat demands of textile processes.

Relative Economy of Textile Industries

The relative fuel economy of the different textile groups is shown in Table 3, derived from data given in Tables 1 and 2. The items are listed in the order of comparative performance as figured on a common basis of power production and show clearly the effect on the overall economy of the extensive use of steam in the various processes of manufacture.

The cotton goods and cordage groups rank first, owing to their small demands for process steam. The relatively good economy shown by the woolen and worsted group may be attributed to a more general utilization of exhaust steam in processes and the better balance usually existing between the steam demands of prime movers and processes.

The dyeing and finishing group has a comparatively small power demand and a most extensive use for process steam. The relation of coal to power in the silk goods group appears out of proportion in comparison with the other industries and must be attributed, in part, to the wasteful use of steam and a more extensive use of the lower grades of fuel.

The validity of the results given in Table 3 may best be shown by citing a number of specific examples of individual plants of different types, giving the actual fuel consumption and power production. This is shown in Table 4. These figures check well with the averages for the respective groups which are given in Table 3.

Importance of Heat Applications

The foregoing facts emphasize in general terms the importance of the problems of heat application to textile processes. These problems warrant far greater attention than they have yet received, both from the standpoint of production efficiency and from the consideration of fuel economy. But little progress has been made along either line in comparison with the marked advances that have taker place in the art of generating steam and power.

Many textile power plants are "saving at the spigot and wasting at the bung" and the average dyehouse, bleachery or print works is usually considered a necessary evil to be endured up to the limit of the boiler capacity of the plant. While production efficiency must be considered as of the first importance, the present fuel situation demands rigid conservation in the use of both coal and steam.

[1] Consulting Engineer, 34 Batterymarch St. Mem. Am. Soc. M. E.

Effects of Heat on Textile Materials

The purposes for which heat is applied to textile materials in process are numerous and varied and only the principal ones will be summarized, as follows:

Process	Material	Purpose or Effect of Heat
Scouring	Wool	To assist the action of the soap and alkali.
Carbonizing	Wools and shoddies	To free the acid from moisture to permit carbonization.
Combing	Worsted wools	To facilitate drawing through the pins.
Dyeing	All materials	To assist the fixation of dyestuffs.
Kier Boiling	Cotton goods	To assist action of liquor in softening impurities.
Drying	All materials	Evaporation and removal of moisture.
Tentering	Cotton and worsted goods	To dry goods under tension retaining width.
Steaming	Woolen, worsted and print goods	To shrink, remove glaze and to set fabrics and colors.
Soaping	Print and dyed goods	Warm water removes surplus color and improves appearance
Ageing	Print and dyed goods	To set or develop colors.
Washing	Woolen and worsted goods	Warm water removes oil and soap applied in previous processes.
Pressing	Woolen and worsted goods	With pressure, flattens surface for finish effect.
Calendering	Cotton goods	With pressure and friction, assists in producing luster.

Classification of Principal Heat-Using Processes

Application	Machines of Similar Use
Direct contact of materials with steam or water vapor	Steamers for woolen goods, print goods, etc. Ageing machines for print and dyed goods Yarn conditioning machines
Direct contact of materials with heated surfaces for warming stock, pressing, polishing, drying, etc.	Worsted comb steam chests Worsted back washers Plate presses for woolen goods Rotary presses for woolen goods Slashers and dressers Cylinder and can dryers Calenders for cotton goods Polishers for twine, thread, etc.
Drying of materials with air heated by direct or indirect radiation	Hot air slashers and dressers Cotton and wool stock dryers Carbonizing dryers Cloth dryers Shrinking dryers Tenter frames Dry rooms for yarn Back washer dryers
Direct use of steam for boiling or heating liquids and use of warm water	Dye tubs and dyeing machines Scouring bowls for wool Bleaching kiers Cloth washers Crabbing machines Starch and size cooking Soapers
Indirect use of steam for heating liquids.	Bleaching kiers with closed heaters and circulating pumps. Jacketed kettles for size, starch or dyestuffs. Tubs and dyeing machines with closed submerged coils. Preheating of liquids for process or storage by closed heaters.

The direct or indirect heating of rooms containing processes requiring careful temperature and humidity control may also be mentioned under the general heading.

Factors Affecting Production and Economy

Some of the various conditions commonly found, which affect either production or economy are as follows:

Production	Economy
Wet steam.	Leakage from traps, vents, etc.
Poorly designed steam distribution system.	Wasted drips.
Incorrect arrangement of traps.	Overheating or overcooling through careless operation.
Deficient trap capacity.	Radiation losses through dryer housings, etc.
Delays in heating liquor, dyes, etc.	Waste of exhaust steam or condensing water.
Inefficient air circulation in dryers.	Lack of hot-water storage.
Deficient dryer radiation.	Failure to recirculate air in dryers.

In addition to the data given above, there is usually little information available either of the steam requirements or

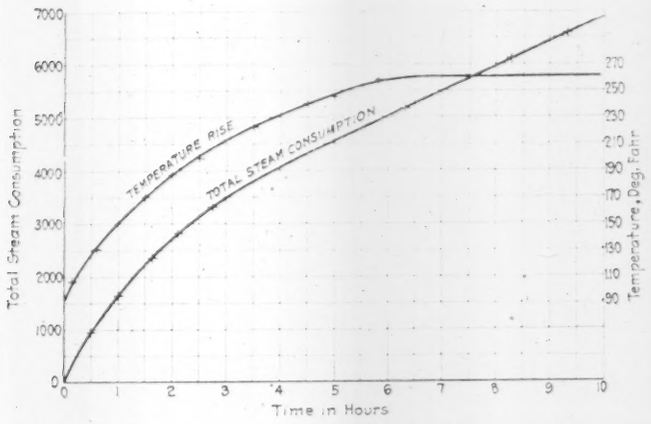

FIG. 1 TEMPERATURE RISE AND STEAM CONSUMPTION IN KIER TEST

demands. While considerable progress is being made in means and methods for correcting the conditions mentioned, there is still room for much improvement.

Many of the larger mills are making complete steam surveys of their plants periodically to check use against demand and also to enable steam costs to be properly apportioned to the various processes. Modern steam meters give reliable results and in-

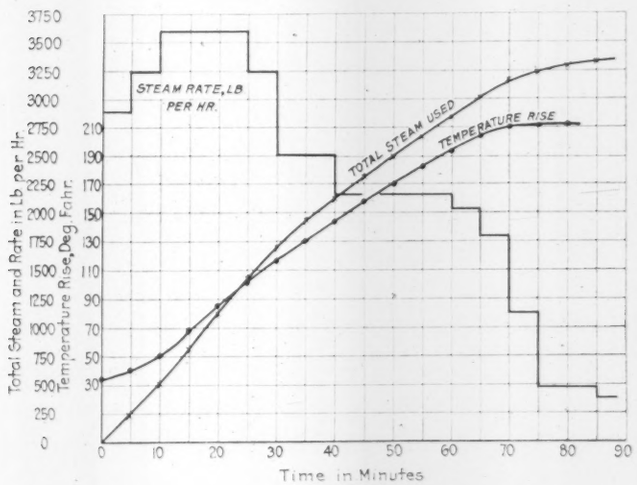
Total Steam and Rate in Lb per Hr.
Temperature Rise, Deg. Fahr.
Time in Minutes
STEAM RATE, LB PER HR.
TOTAL STEAM USED
TEMPERATURE RISE

FIG. 2 TEMPERATURE RISE AND STEAM CONSUMPTION IN DYE-TUB TEST

variably reveal many surprising conditions which require attention and which cannot be disclosed by any other means.

TEST RESULTS

The results of tests made at different plants are given in the following tabular form, and in Figs. 1 and 2, merely to illustrate common practice and not as standards of high performance. They will however be found useful for comparative purposes.

SUGGESTIONS FOR INVESTIGATION AND IMPROVEMENT

It is hoped that the outline given of this subject will help to stimulate greater attention to this important matter.

The following suggestions are offered as concrete lines for useful and practical study and research:

a Further investigation of conditions of temperature, humidity and air circulation for drying various materials with maximum production and minimum heat consumption

b Development of more efficient arrangement of radiation and air circulation in dryers

c Automatic control of the production rate of dryers, through conditions resulting from drying results obtained

d Further development and application of temperature control devices to heat using processes

e More effective utilization of exhaust steam in processes, heating water storage, etc.

f Recovery of heat from spent and rejected liquors.

g Development of insulating materials to be used under conditions where equipment is subject to extreme moisture conditions or to mechanical injury

h Use of supplementary air circulation with can dryers.

The field is a broad one with many varied and complex problems, but the coöperative effort of manufacturers, machine builders and engineers should bring about much needed improvement in the present average practice.

TABLE 1 COAL CONSUMPTION AND STEAM-POWER REQUIREMENTS OF THE TEXTILE INDUSTRIES

Industry	Anthracite, 1000 Tons of 2240 lb.	Per Cent of Total Anthracite	Bituminous, 1000 Tons of 2000 lb.	Per Cent of Total Bituminous	Steam Power, 1000 Hp.	Per Cent of Total Steam Power
Carpets and Rugs	74.7	3.1	193.7	2.7	29.5	1.8
Cordage, Jute Twine and Linen	91.9	3.8	195.2	2.7	65.8	4.0
Cotton Goods	313.5	13.0	3634.2	50.0	1011.3	60.7
Dyeing and Finishing*	490.6	20.5	896.6	12.4	111.5	6.6
Hosiery and Knit Goods	118.1	4.9	484.3	6.7	80.8	4.9
Silk Goods	1053.7	44.0	249.9	3.5	78.3	4.7
Woolen, Worsted and Felt	257.4	10.7	1608.8	22.0	288.7	17.3
Total	2389.9	100.0	7262.7	100.0	1665.9	100.0

*Exclusive of that done in textile mills.
Fuels other than coal have been omitted as the equivalent total is small.

TABLE 2 DISTRIBUTION OF PRIMARY POWER IN THE TEXTILE INDUSTRIES

Industry	Total Primary, 1000 Hp.	Steam Power, 1000 Hp.	Water Power, 1000 Hp.	Internal-Combustion Engines, 1000 Hp.	Rented Power	
					Electric, 1000 Hp.	Other, 1000 Hp.
Carpets and Rugs	44.0	29.5	4.1	....	9.2	1.2
Cordage, Jute Twine and Linen	93.9	65.8	14.4	2.8	10.7	0.2
Cotton Goods	1585.9	1011.3	314.2	4.0	252.9	3.5
Dyeing and Finishing	130.1	111.5	9.9	0.7	7.2	0.8
Hosiery and Knit Goods	125.7	80.8	14.6	1.1	26.3	2.9
Silk Goods	117.0	78.3	7.6	1.8	23.8	5.5
Woolen, Worsted and Felt	398.4	288.7	76.3	2.7	25.0	5.7
Total	2495.0	1665.9	441.1	13.1	355.1	19.8
Per Cent of Total	100.0	66.8	17.7	0.5	14.2	0.8

TABLE 3 COMPARATIVE FUEL ECONOMY OF THE TEXTILE INDUSTRIES

Industry	Equivalent Bituminous (1000 Tons of 2000 lb.)[1]	Per Cent of Total	Steam Power 1000 Hp	Per Cent of Total Primary Power	Tons Per Hp. Per Year	Lb. Per Hp. Per Hr[2]
Cotton Goods	3947.7	40.8	1011.3	63.7	3.90	3.12
Cordage, Jute, Twine and Linen	287.1	3.0	65.8	70.0	4.35	3.48
Woolen, Worsted and Felt	1866.2	19.3	288.7	72.3	6.50	5.20
Hosiery and Knit Goods	602.4	6.2	80.8	64.5	7.45	5.96
Carpets and Rugs	268.4	2.8	29.5	67.2	9.08	7.26
Dyeing and Finishing	1387.2	14.4	111.5	85.8	12.50	10.00
Silk Goods	1303.6	13.5	78.3	67.0	16.70	13.36
Total	9662.6	100.0	1665.9	66.8	5.80	4.64

[1] Anthracite ton of 2240 lb. included as equivalent of Bituminous ton of 2000 lb.
[2] Based on 2700 hr. operation per year.

TABLE 4 ACTUAL ECONOMY OF INDIVIDUAL PLANTS

Kind of Plant	Total Coal Tons	Total Steam Power Hp.	Coal Per Hp. Per Year
Cotton goods, no dyeing	10,500	2,800	3.75
Cotton goods, with dyeing	13,000	3,000	4.33
Jute goods	9,400	2,200	4.28
Worsted yarns	1,560	340	4.6
Woolen goods	1,800	270	6.67
Bleachery and finishing	10,200	800	12.75
Print works	60,000	4,000	15.00

TABLE 5 CLOTH DRYER TESTS

	Uninsulated Housing Woolen suiting	J-M No. 1 Type Insulated Housing Woolen suiting
Weight of goods, oz. per yd	13	13
Weight of wet goods processed per hr., lb.	900	1047
Weight of goods dried per hr., lb.	523	609
Yards dried per hr., lb.	644	747
Weight of water evaporated per hr., lb.	377	438
Per cent moisture in wet cloth	41.9	41.9
Heating surface, sq. ft.	2240	2240
Steam pressure, gage	42.5	43.5
Temperature in dryer	135 deg. fahr.	189 deg. fahr.
Weight of steam condensed per hr., lb.	875	738
Steam condensed per sq. ft. of radiation	0.39	0.33
Steam per lb. of dry cloth, lb.	1.67	1.21
Steam per lb. of moisture evaporated	2.32	1.85
Yards dried per lb. of steam	0.735	1.01

TABLE 6 CARBONIZING DRYER TEST

	Uninsulated Housing Woolen and cotton thread waste	J-M No. 1 Type Insulated Housing Woolen and cotton thread waste
Weight wet stock processed per hr., lb.	402	585
Weight stock dried per hr., lb.	266	391
Weight of water removed per hr., lb.	136	194
Per cent moisture in wet stock	32.4	33.3
Heating surface, sq. ft.	2488	1952
Temperature in dryer	279 deg. fahr.	261 deg. fahr.
Steam pressure, gage	80	80
Weight of steam condensed per hr., lb.	1044	432
Steam condensed per sq. ft. of radiation, lb	0.42	0.22
Steam condensed per lb. of dry stock, lb.	3.93	1.11
Steam condensed per lb. of moisture removed, lb.	7.68	2.23

Note: The author wishes to acknowledge the contribution of the above tests on insulated and uninsulated cloth and stock dryers from the H. W. Johns-Manville Co.

TABLE 7 TENTER FRAME TESTS

Aver. weight of cloth, yd. per lb.	5.4
Duration of test, hr.	7.0
Steam pressure, gage	30 lb.
Outside temperature	70 deg. fahr.
Temp. of air supplied, dry bulb	163 deg. fahr.
Temp. of air supplied, wet bulb	85 deg. fahr.
Temp. of return air, dry bulb	138 deg. fahr.
Temp. of return air, wet bulb	84 deg. fahr.
Air supplied, cu. ft. per min.	8700
Weight of cloth dried per hr., lb.	650
Weight of water evaporated per hr., lb.	106
Per cent of water in wet cloth	14

	Without air recirculation	With air recirculation
Steam condensed per hr., lb.	1122	433
Steam per lb. of dry cloth, lb.	1.71	0.67
Steam per lb. of water evap., lb.	10.5	4.1
Lb. of cloth dried per lb. of steam	0.58	1.5
Yd. of cloth dried per lb. of steam	3.23	8.1

TABLE 8 CAN DRYER TESTS

Test No.	1	2	3	4	5
Wt. of goods, yd. per lb.	1.45	2.5	5.15	8.10	10.85
Kind of goods	Shoe Lining	Shoe Lining	Sheeting	Twill	Lawn
Steam pressure in cans, gage	5.7	4.7	8.1	5.5	5.3
Number of cans	47	47	47	23	13
Size of cans	23in.x100in.	23in.x100in.	23in.x100in	23in.x141in	36in.x124in.
Material of cans	Copper	Copper	Copper	Tinned Iron	Copper
Total can surface, sq. ft.	2350	2350	2350	1625	1265
Cloth dried per hr., yd.	2393	4420	10,135	17,750	12,730
Cloth dried per hr., lb.	1650	1768	1968	2191	1173
Per cent of water in wet cloth	48.8	51.8	51.7	46.1	44.4
Water evaporat. per hr., lb	1570	1892	2112	1873	908
Steam condens. per hr., lb	2462	2625	3424	2530	1310
Steam per lb. dry cloth, lb	1.49	1.48	1.74	1.15	1.12
Steam per lb. water evaporated, lb.	1.57	1.39	1.62	1.34	1.40
Number of strings	2	2	2	4	4
Average speed yd. per min.	20	36.5	84	74	50
Yards of cloth per lb. steam	0.97	1.68	2.96	7.00	9.7
Steam per hr. per sq. ft. can surface	1.05	1.12	1.46	1.56	1.04

TABLE 9 KIER TEST (SODA BOIL)—SEE FIG. 1

Size and kind of kier	4 ton, pressure type, injector circulation
Weight of dry cloth	8000 lb.
Kind of cloth and wt. in yd. per lb., muslin 56 x 52	7.25 yd.
Weight of water entering goods	8000 lb.
Weight of liquor	16800 lb.
Initial temperature	80 deg.
Final temperature	245 deg.
Steam pressure, gage	25 lb.
Time of boil	10 hr.
Total steam used	8250 lb.

APPROXIMATE HEAT BALANCE

	Pounds of Steam	Per cent of Total
Heating wet goods	2264	27.5
Heating liquor	2971	36.0
Heating kier	238	2.9
Radiation loss	1860	22.5
Vent, evaporation and accounted for losses	917	11.1
Total	8250	100.0

TABLE 10 DYE TUB TEST—SEE FIG. 2

Gallons of liquor boiled	1845
Pounds of liquor boiled	15300
Initial temperature	34 deg. fahr.
Final temperature	210 deg. fahr.
Total temperature rise	176 deg. fahr.
Time of total temp. rise, min.	70
Total steam used during total temperature rise, lb.	3230

The Causes of Industrial Unrest and the Remedy

Labor Unions Have Promoted Inefficiency and Decreased Production—Employers Have Been Remiss in Regard to Industrial Relations—Each Shop Must Work Out Its Own Salvation Through Fair, Cordial and Sympathetic Co-operation

By FREDERICK P. FISH[1], BOSTON, MASS.

EVEN under normal conditions, there is no phase of our modern social organization which is more complicated and exacts more from the intelligence, character and capacity of mankind than the machinery and methods of production and distribution by means of which our material needs are satisfied. But at the present time, conditions are not normal. Everything has been thrown out of adjustment by the Great War. There has been a destruction of property, the effect of which will embarrass us for years, and millions of men who would have worked and produced have been killed or incapacitated. But this is not all. The thought of the whole world has been disturbed. A condition almost approaching hysteria has been developed so that everywhere men are incapable of cool, sane judgment not only as to the facts of the existing situation but as to their needs and aspirations.

Decreased Production and Its Causes

Leaving out of consideration all matters of governmental disturbance and confining our thought only to production, it seems certain that at the very time when there should be the greatest effort to produce, that we may make up for the losses of the last five years and establish our material resources on a sound basis, the attitude of workmen throughout the world is such that individually and as a whole their efficiency and productive power are much less than before the war. While in other parts of the world they are working under unfavorable conditions, that is not the case in this country. Here the sole reason for reduced efficiency is the atmosphere that has been developed, which results not only in strikes but in a definite attitude on the part of the worker that he will not produce to the extent of his reasonable ability. In spite of the fact that he is constantly demanding greater pay, he is insisting upon shorter hours and is disinclined to exert himself while at work. He almost cultivates a spirit of antagonism to the enterprise for which he works, forgetting that his interests and those of his employer are identical and that only by close coöperation can results be attained that will lead to the prosperity of either. The influence of labor unions, not only in the "closed shop," where with the acquiescence of the employer they largely dominate the situation, but in many of the so-called "open shops," in which are labor-union workmen influenced by the principles of the labor unions, is such as to promote inefficiency on the part of the workmen. Some deliberately refrain from effort, but I believe it to be the case with a large majority that, against their inclination, they fail to make proper effort because of fear. They do not dare to act contrary to the spirit instilled by the labor unions and labor-union men, which causes them to be treated as traitors to their class if they do all that they would gladly do by way of loyal devotion to their work.

Only this week the manager of a large plant told me casually of some of the conditions with which he has to contend. In one room where a large number of workmen are assembling a certain article, each and every one of them produces exactly fifty a day and twenty-five a half-day of the working period. It is, of course, absurd to suppose that the capacity of each and all of a very large number of workmen should be so uniform as to lead to this result, unless there was a standard deliberately adopted and maintained. This same manager told of another circumstance which illustrates the same spirit. He has procured a machine which with one man will do the work heretofore done by eight men. Up to date he has been utterly unable to find a man in his establishment who will run that machine. The absurd fallacy that it is for the interest of wage earners that each should do little work, ineffectively, that more may be employed, prevails to a substantial extent under the influence of the labor unions.

In this plant to which I have just referred, wages have increased on the average 110 per cent since 1914, although the cost of living has not increased more than about 75 per cent, and the manager is satisfied that the efficiency of the individual workmen has been reduced during the same period about 40 per cent.

There is ample testimony that the situation is the same throughout the country.

Of course, it is the public, the consumer, that ultimately suffers from such failure on the part of the workers to recognize their duty as factors in production. For the moment at least, owing to the abnormal situation throughout the world, the employers are able to add to the price of their manufactured articles enough to make up for this absurdly unnecessary and vicious added cost of production, so that the public pays the bill. But such conditions cannot continue, and the time is surely coming when our industries will be unable to recoup themselves in this manner, with a resulting period of industrial depression which may well be the most serious in history.

Reasons for the Present Unsatisfactory Employment Relations

What is the reason for these unsatisfactory employment relations and how can they be cured? To answer these questions, brief reference must be made to certain facts of recent industrial history, the importance of which should be clearly understood.

While the present unsatisfactory conditions have been accentuated by the war, they had existed, although to a lesser degree, for many years prior to 1914 in this country and even to a greater extent in England.

I believe the fundamental difficulty to be that industry has not had time to adjust itself to the extraordinary new conditions that have prevailed during the past forty or fifty years. While there is no more wonderful chapter in the history of the world than that of industrial progress during the period above mentioned, those who were in control of the industries and directed their progress and upon whom was the duty of assuring satisfactory employment relations under all conditions of effort, were so absorbed in the tremendous task of meeting the material advances in the arts, in responding to the vital changes in industrial methods and in securing the proper utilization of new and extraordinary resources that were for the first time available, that they overlooked and neglected the essential matter of properly adjusting the employment relation to new conditions.

The result of all this progress was great corporations and great manufacturing establishments such as were not even foreshadowed in former days, attended by the extraordinary development of power and of machinery on a large scale which was based upon marvelous inventions and striking achievements in engineering such as the world had never seen. Craft and hand-

[1] Chairman National Industrial Conference Board.

This contribution and the two succeeding ones, by Dr. Leiserson and Dean Heilman, were given at the Industrial Relations sessions of the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, December, 1919. These three addresses, and the paper by Mr. A. L. De Leouw on Wage Payment, published in the December, 1919, number, constitute a symposium on "The Industrial Situation in Relation to Present Condition," a general account of which is given elsewhere in the present issue. These addresses are here given in abstract and are subject to revision.

work were to a large extent eliminated. Vast numbers of workmen were brought together in individual factories, where their activities were specialized to such an extent that each man became trained to a high degree of efficiency in some line to which he devoted his energies exclusively. Only by organization of the most complicated character was it possible to deal with these new conditions; and organization took the place of that personal and direct control by management which had formerly prevailed. In such a radically new environment it was impossible for employment relations to remain as they were before. They inevitably required readjustment. Personal touch between the employer and employee, such as had existed from the beginning of history, was no longer possible. Where such personal relations exist there must be serious fault on one side or the other if they are not harmonious.

If organization is to take the place of such personal contact, it must be made to fit the conditions.

There can be no doubt that the achievements of those who have been responsible for our industrial development during the last fifty years are worthy of the greatest praise. They were secured by a wonderful exhibition of power, intelligence and capacity on the part of a large number of devoted servants of industry. But in the stress and strain of their efforts they could not cover the whole ground. Some aspects of the situation were neglected.

One illustration of this is familiar to us all. As business interests and business men became more and more efficient and powerful, evils appeared such as always attend a great and sudden social movement accompanied by strenuous effort and marked success. Those evils were due to the same weakness of human nature which has caused the bad to be mingled with the good in every great forward step in the progress of our race, whether in religion, in methods of government or in measures of social reform. They arose because management failed adequately to correlate industrial progress with the public interest.

The time came when the public dealt in its own crude way with a situation which it did not approve. Some twenty-five or thirty years ago it became persuaded that the "captains of industry," whom the public had idolized up to that time, and their associates, were developing the industries on lines that seemed contrary to the general interest. Big business became unpopular. The result was a public sentiment which, while it has undoubtedly brought about a needed reform in industrial methods and the relations of industries to the community, has surely been carried so far as to embarrass business to the disadvantage of society. Such a reaction was inevitable, for the people will and should resent the exercise of undue power on the part of any class, no matter what may be its obligation to that class for real service.

Another direction in which management failed to do its full duty was in the employment relation. It proceeded in its strenuous efforts to advance the industries without recognizing that the conditions of employment were such that they required to be approached from a new point of view. Things were allowed to drift and finally came to a point, even before the war, which threatened trouble of a deep-seated and far-reaching character.

We now see clearly that enough attention was not given to the conditions under which men worked, to the principles upon which their compensation should be determined, to their health and comfort not only in the factory but at home. We recognize that the new and strenuous activities forced upon the workmen by modern machinery, which often determine the pace at which men shall work, required careful study that the length of the working day might be properly determined in view of the new environment in which the work was carried on. Enough attention was not paid to the effect upon the workmen of the intense specialization and concentration of their work, as compared with the greater variety and slower methods of former days. Due consideration was not given to the question whether or not the fundamental law of supply and demand, which will always be potent in determining the workman's compensation, might not properly be supplemented to some extent by other considerations. The serious matters of unemployment and the current practice, which seemed unavoidable, of hiring many men to secure a few, were not strongly dealt with.

If these subjects had been studied and the new problems properly worked out, there is no doubt in my mind that the feeling of dissatisfaction, almost of antagonism, on the part of the workmen that finally came into the industries would, to a large extent, have been avoided. It must not be forgotten that contented workmen, whose surroundings are satisfactory and whose health and comfort are maintained, are likely to work so efficiently as more than to compensate for the shortening of hours of work, if they are too long, and for the expense involved in giving them surroundings conducive to health and reasonable comfort; and that added efficiency is promoted by and should be recognized to some extent by increased remuneration, irrespective of what may be called the "market rate" for labor.

As discontent grew among the wage earners, and employers did not wake up to the necessity of trying to meet their aspirations, reasonable or unreasonable, as to better working conditions, and of educating them to sound views of the matter, it

"The influence of labor unions, not only in the 'closed shop,' where with the acquiescence of the employer they largely dominate the situation, but in many of the so-called 'open shops,' in which are labor-union workmen influenced by the principles of the labor unions, is such as to promote inefficiency on the part of the workmen.

"They seem determined to carry on their war against civilized society, for that is what it really is, to the limit and to secure if possible the control of our industries by threats and force. If they should succeed by such methods, a law of brute force would be established which would mean the end of our Government and of society.

"There is no doubt, however, that the labor unions have also accomplished much good. Among other things they have focused the attention of industrial management and of the public upon those features of employment relations which needed study and revision. It may even be possible that the vicious methods of the strike and the boycott and the brutal and even criminal pressure brought by the trade unions upon non-union workmen and their families, as well as upon employers, have contributed to opening the whole question for proper consideration.

"There can be no specific general cure, no panacea for the evils that exist, either by way of legislation or of reorganization of our social or industrial methods; but the present unfortunate antagonism between employers and employees and the existing disturbance of the cordial feeling that should exist between them can be eliminated and right conditions restored only by definite personal effort to develop and maintain, in the individual industrial establishments of the country, suitable employment relations, based in each instance upon fair, cordial and sympathetic coöperation and a recognition of what is right and proper in the particular establishment."

FREDERICK P. FISH.

was but natural that the trade and labor unions should succeed in bringing many workmen into labor organizations which seemed to them to promise relief from what they regarded as unsatisfactory working conditions. There is no doubt that the labor unions have accomplished much good. Among other things—and this is probably where they have been of chief value—they have focused the attention of industrial management and of the public upon those features of employment relations which needed study and revision. It may even be possible that the vicious methods of the strike and the boycott and the brutal and even criminal pressure brought by the trade unions upon non-union workmen and their families, as well as upon employers, have contributed to opening the whole question for proper consideration.

Arbitrary Attitude of Labor Unions

But from the beginning the labor unions have adopted social and economic principles that were unsound and methods of propaganda and of action that should not be tolerated in any civilized society. They have worked for the suppression of production upon the false theory that the less men worked, the more men could be employed. On the same ground they have not been sympathetic to the introduction of improved machinery and have often opposed its use. They have undertaken to establish a closed organization which would prevent the employment of workmen who would not yield themselves body and soul to the dictation of labor-union leaders. In this way they have been the enemies of society and of unorganized labor. They have been opposed to apprenticeship systems and vocational education as likely to add to the number of competitors for the jobs of labor-union men. They have undertaken to enforce arbitrary and unreasonable rules in factories and to interfere with the proper execution by the management of its necessary prerogative of control. Not to speak of such crimes as those of the McNamaras, they have often violated the laws of the land as well as the principles of good morals. They have fostered and encouraged mob rule. They have tacitly and even directly encouraged assault and destruction of property as a means of winning the strikes upon which they relied for accomplishing their purposes. They have refused to be bound by the law and have too frequently, by the exercise of pernicious political influence based largely upon threats, obtained special exemptions from provisions of law than no one else could violate with impunity. They have practiced intimidation on the wives and families of workers and interfered with the inherent right which every man has, to choose his own way of getting a living, provided it is lawful.

They have used the fact that they were rich and powerful organizations, purporting to speak for a large number of men—who were, in theory, bound to work and vote as a unit—to further legislation for their own selfish purposes and not in the public interest. They have openly expressed disrespect for the law and courts and have shown that disrespect by their conduct. All these charges are capable of proof and are recognized as valid by those who are familiar with such matters.

There is no doubt that many of the labor-union leaders have been good men, working for what they regarded as the interests of the workmen. It is also a fact that some individual labor unions have been so reasonable in their activities that employers have found it possible to work with them with satisfactory results. But generally speaking, such has not been the situation. It is always the case in such organizations that a small element of active, virile and intelligent leaders, carried away by the desire for power and by their own ambitions, find themselves almost instinctively adopting such wrong and brutal methods as the exigencies of the case seem to require, on the theory that the end justifies the means. Moreover, their hands are forced by what they regard as the necessity of getting results. The majority of those who follow them are naturally good and law-abiding citizens, but in addition to the fact that pressure, even to the point of violence, is brought to bear upon them and their families, they become blinded in their devotion to the cause and fail to see things in true perspective; even if they do not approve of what is done in their name and ostensibly on their behalf, they have no power to control the situation. They are carried along by a stream too strong to permit the exercise of individual judgment.

Up to the time of the war, the American Federation of Labor, which stood for the recognized labor unions in this country, had succeeded in securing a membership of less than 10 per cent of the workers in industry. Considerably less than 10 per cent of the shops in the country were "closed shops," that is to say, shops in which the labor unions dominated. The "open shop" principle had been substantially maintained. This country therefore did not suffer as it would inevitably have suffered if the labor unions had been really a dominant force. In England, where they had been much more successful in securing the control of the employment relation, the consequences of their power and influence were clearly seen. Before the war, the individual American workman was turning out from two to three times the product turned out by the English workman. Because of his greater productive power, his wages were higher and his living conditions much better than in England. In the latter country, production was so reduced by labor-union rules and by the hostility to improved machinery, fostered by the labor unions, that England was rapidly losing her standing as a manufacturing nation, while at the same time wages and the standards of living of her workmen were extremely low. This was inevitable, for there was no large production from which good wages could be paid, large production being the only source from which increased returns to the workers can be derived.

When the war broke out, England found that under existing conditions she could not begin to produce what was required for fighting purposes and the support of her army and her people. There was only one thing to do, which was to persuade the labor unions to suspend their rules and abandon their characteristic methods during the period of the war. By great pressure from the Government they were induced to take this course, with the result that production was increased in England to an astonishing degree; but the labor unions made this sacrifice of what they regarded as their interests, only with the distinct understanding that, after the war, they should be allowed to reinstate themselves as a controlling force in industry. They are now trying to bring about this revival of the old condition of things. If they succeed, England as an industrial nation is doomed.

When we entered the war there seemed to be a fear, which was probably unfounded, that the organized workmen in this country had no patriotism and no thought of the public welfare. There seemed also to be a feeling on the part of those in power that the labor unions, represented by the American Federation of Labor, controlled the situation and must be placated in any event. There probably was no foundation for this feeling, but on this theory the entire influence of the Government during the war was on the side of yielding everything to the labor unions. The Government throughout the war seems largely to have followed the dictation of the labor unions. It certainly used its influence to force the employers of the country to yield to the organized workmen practically everything that was demanded, not only as to wages and working conditions but in the matter of unionizing the shops. This seems to have been the uniform policy from the date of the Adamson Bill, which was the first expression of it on a large scale.

The results have been that while every other section of the community, including unorganized labor, made substantial financial sacrifices to aid in winning the war, workmen in industry have been called upon to make no such sacrifice. Their wages have gone up far more than has the cost of living and today they are the conspicuous class in the community which has money to spend on luxuries to an extent never known before. And yet, during the war organized labor promoted an infinite number of strikes to the great embarrassment of the Government and loss to the public. Many, and perhaps most of these strikes centered about the question of recognition of the labor unions by the employers.

Determination of Labor Unions to Dominate Industry

The great increase in power and influence which the labor unions have secured as the immediate result of the war, as well as their determination to dominate industry at all costs, is reflected in the steel strike, the coal strike and innumerable other strikes throughout the country, while one phase of their aspirations is illustrated by the strike of the Boston police. They threaten a railroad strike and even a general strike unless their demands, which are clearly unreasonable, are complied with. Either would cause intolerable hardship to the community. They seem determined to carry on their war against civilized society, for that is what it really is, to the limit and to secure if possible the control of our industries by threats and force. If they should succeed by such methods, a law of brute force would be established which would mean the end of our Government and of our society. There is no need to argue what a serious matter this would be for our industrial prosperity. But it also should be noted that if the labor unions succeed in this effort, they will establish an *imperium in imperio* in this country which will be utterly inconsistent with proper Governmental control and with the ideals of a free, democratic community.

There are at the outside something more than four million workmen who are members of the labor unions, not over 10 per cent of all the wage earners in the country. More than that, there is reason to believe that a substantial number of the men in the labor unions do not sympathize with the underlying aspirations of the leaders or the methods adopted by them. The recent election in Massachusetts is an indication that the workmen of this country are not in sympathy with such high-handed procedure. And there is much further evidence to the same effect.

In addition to the trade and labor unions associated with and in the American Federation of Labor, there are other labor unions of the same type, of which the railroad brotherhoods are the strongest and most important. There are also other associations of wage earners to which a brief reference must be made. Many of these, the so-called Independent Workers of the World being the most conspicuous, are distinctly revolutionary in character and criminal in act and intent. The normal American workman has no sympathy with their real aims and purposes, but some are deceived into believing that they will help to secure better conditions of living. The greatest strength of these lawless organizations is with the foreign-born worker who is not at all an American and whom it is easy to mislead. They are, in theory, opposed by the trade and labor unions partly because it is the policy of those last-named organizations to resent the intimation that they are aiming at the destruction of society and partly because their leaders are afraid that, by some wave of sentiment, the rank and file of the labor unions may be carried over into the other and more radical camp and new labor-union leaders selected in the place of those now in power.

It cannot be overlooked, however, that while the trade and labor unions have stood in opposition to the I. W. W. organization, and others like it, and have proclaimed their hostility to the destructive and revolutionary policy of such organizations, they themselves in their underlying principles, as well as in their practices and conduct, have laid the foundation for just such revolutionary and destructive ideas as those which their rivals have openly proclaimed and promoted.

It is incredible that at the present time there should be any danger of such public support of these revolutionary organizations as would make them a serious menace to our industries, to our Government and to our civilization. There is far greater danger that the trade and labor unions may play a conspicuous part in the future of our country, for at any rate until recently the people as a whole, carried away by sympathy, have been inclined to overlook their faults and even their crimes and to regard their activities with a certain degree of favor. The real question is this: Shall a series of organizations, welded into one great parent organization of enormous wealth and strength, be allowed to have and to exercise such power that it may at will paralyze our industries, and by methods such as are illustrated by the great strikes above referred to, and by threats—even threats to starve our people—attempt to secure its own selfish ends irrespective of the interests of the rest of the community? The answer to this question seems clear.

The same instinct on the part of the public which led to the more or less warranted attack upon big business some twenty years ago should bring about among our people a recognition of the tremendous danger involved in the improper and brutal exercise of power threatened by the labor unions. If public sentiment is once aroused, the end is certain. The American people will surely not submit to the domination of any class working solely in its own supposed interest for power such as no class should have.

The extraordinary efforts now made by labor unions have as their foundation no present grievance on the part of the workingman, for none of any real moment exists. The unions are simply taking advantage of the condition of dissatisfaction and mental disturbance on the part of the wage earners, the beginnings of which were before the war but which have been fostered and promoted by the circumstances of the war period. So long as that mental and moral condition continues, the field is open for labor-union propaganda and worse. If they succeed in their efforts the result will surely be inefficiency of production, inharmonious employment relations and the possibility of even worse developments along the lines of the aspirations of those who would destroy our civilization and our Government.

How to Remedy the Existing Situation

I have tried briefly to present certain phases of the existing situation and to show in part how present conditions arose. The great question, and it is the most serious with which we are now confronted, is how to deal with this existing situation. There are some, even among those who are intelligent and have given more or less attention to the subject, who seem inclined to believe that the solution of the present difficulties in the employment relation resides in the further development of the trade and labor unions and of their policies. They picture a condition of things in which all workers are organized and perhaps all employers in like manner organized. Then the labor unions on the one hand and the employer organizations on the other are to get together and by "collective bargaining" settle for all the industries all questions of wages, hours of labor, conditions of employment and other relations between employer and employee.

I am convinced that such a plan, if adopted, would be destructive of our industries and fatal to our prosperity and to our life as a free people. The whole history of the labor unions in this country and abroad shows that the result would be marked inefficiency, limited production and no real improvement in the relations of the wage earners and the employers. It is to me inconceivable that any one who has studied the subject should come to the conclusion that such a plan is even to be seriously considered.

Others talk loosely of the "democratization of industry," a vague phrase which seems to imply a more definite participation on the part of the workmen not only in the control of employment relations but even in management.

There is no reason to believe that the workmen themselves have any such aspirations and it is certain that the right and obligation of management to exercise its necessary function of direction and control must always be definitely recognized and maintained. Such suggestions are too vague for intelligent consideration.

No Panacea Available for Existing Evils

It is my firm conviction that there can be no specific general cure, no panacea for the evils that exist, either by way of legislation or of reorganization of our social or industrial methods; but that the present unfortunate antagonism between employers and employees and the existing disturbance of the cordial feeling that should exist between them can be eliminated and right conditions restored only by definite personal effort to develop and maintain, in the individual industrial establishments of the country, suitable employment relations, based in each instance upon

fair, cordial and sympathetic coöperation and a recognition of what is right and proper in the particular establishment.

Not only is the cost of labor far and away the largest item in practically all industry but men and women, unlike machinery, to a large extent control their own actions even when under discipline and must not only be trained but must be in the right frame of mind. If they work in a cordial spirit and with good will, the results are far greater than if their efforts are perfunctory. It would seem certain that an intensive study of this human relation in an industrial establishment would result to even greater advantage than the same amount of attention given to the material factors.

In this direction much has been done during the past few years and with good results. There has been a marked improvement in working conditions throughout the country. Sanitary and hygienic arrangements and devices protecting against danger have been introduced to a large extent. Shop hospitals and nurses are common in the industries. Definite and well-considered efforts have been made to promote the living and housing conditions of employees and to give them opportunity for healthy and stimulating physical and mental recreation.

Improved Working Conditions Better Employment Relations

There is no doubt that the employment relations have been bettered by these improvements in working and living conditions. They must have resulted in better health and greater efficiency and have developed a better feeling on the part of the workers.

Such methods should be adopted in every establishment to the extent to which they are justified by the conditions in that establishment, not only as a plain duty to the workmen but because they are a profitable investment leading to better service. Everything, of course, depends upon the spirit in which such efforts are made and accepted by the workmen. If they come as a natural, reasonable incident to the employment relation and not in such a way as to offend the just pride of the employee, their effect must be wholly good.

But such efforts are not enough. The workman is primarily interested in the more essential matters of wages, hours of labor, continuity of employment, and the fairness of the rules and regulations under which he works and of the spirit in which those rules and regulations are applied.

In all these matters he has inevitably personal views to which consideration should certainly be given, not to an extent which will interfere with the necessary control by management, but to an extent which will enable management to act intelligently and sympathetically. If in such matters the workmen can be made to feel that they are treated as men, with rights that are recognized and respected, they will surely be in a much better frame of mind and more likely to respond with a reasonable view as to that to which they are entitled.

It is not unnatural that while they must take orders and must work under rules that are essential to the carrying on of the business, they should feel dissatisfied if they have nothing to say as to their wages, hours of work and working conditions, but are in a position where they must take without protest what is offered to them or give up their job. No man likes to have another say to him, "Take it or leave it," without explanation or discussion.

It therefore seems certain that in each individual industrial establishment there should be the same scientific effort to study the men in their relations to the work as to analyze the materials, machinery and shop methods, in order that the best possible results may be produced. If instead of holding the workmen at arm's length, they could be taken into the confidence of the employer as to wages, hours and working conditions, it seems but reasonable to believe that a feeling of mutual confidence and willing coöperation would be developed which would be a most distinct asset to the business and likely to hold the men against any of the superficial inducements offered by trade and labor unions, which endeavor to excite antagonism on the part of the workmen toward the enterprise in which they are essential factors.

The burden of the effort to bring about such relations must be consciously and definitely assumed by the management in each individual establishment. From that management the initiative must come with the hope that the employees will respond.

Each Employer Must Solve His Own Problem

No hard and fast rules on the subject can be laid down. Each employer should study his own problem and attempt to deal with it in view of the conditions in his own establishment, exactly as he works out his mechanical and technical problems in harmony with the requirements of his own work and with only general reliance on the experience of others.

Of the 450,000 manufacturing establishments in this country, the large majority are so small that it is still possible for the old-fashioned personal contact between employer and employee to continue. In such cases all that may need to be done is that the employer should treat his workmen as reasonable beings, whose inevitable interest in their own affairs entitles their views to frank sympathetic consideration. He should not hold them at arm's length. He should learn their ideas and their criticisms of their relations with him. He should endeavor to satisfy them of the reasonableness of his attitude in the matters that are of such vital importance to them. He should see that they understand the conditions of the business. He should let them know why the wages and hours of labor should be fixed at a certain standard and the reasons for the rules and regulations that are adopted. He should acquaint them with the difficulties under which he labors, in so far as those difficulties are material to a full understanding of the exact situation. He should invite their suggestions as to ways, large and small, by which shop methods may be improved or the product and quality of the goods increased. He should be willing to discuss with them, under proper conditions, all the questions in which employer and employee are jointly interested. He should listen to the complaints of the men, recognizing that if matters of complaint are dealt with promptly it is generally easy to dispose of them.

All this could be done by an intelligent, sympathetic employer without the expenditure of much time or effort, and there is no doubt that he would find a real satisfaction in the energy so expended.

Where the number of men employed is so large that personal contact is impossible, each employer should make every effort to work out a plan by which, in view of the conditions in his own establishment, he can get the equivalent of such personal contact. There is more than one way of bringing about this result. In some cases, it might be accomplished by the organization of a special department whose duty it would be to keep in close touch with the men and establish with them the confidential relations that are required.

Good Results from Establishing Shop Councils

Another plan that seems promising and which has already been adopted in several hundred establishments in this country, in some of which it is working with marked success, is the establishment of shop councils or some other form of shop or plant organization by which representatives of the employees, honestly selected by them from their own number, meet regularly with representatives of the employer to consider, in conference, the questions arising under the employment relation.

There is every reason why the employees should welcome such an opportunity to meet representatives of the employer. Such an arrangement would appeal to the sense of fairness of the employees and if the conferences were conducted as they should be on terms of perfect equality and with entire frankness, the results could not be other than beneficial. Experience seems to show, what it is only natural to expect, that representatives of the men selected for such purposes, under conditions which insure an honest election and a fair count, would be intelligent and reasonable. Through them the men would learn much that they never otherwise would know as to the troubles and aspirations of the management, the difficulties of carrying on the business

and the reasons for the adoption of one policy or another in the employment relation.

If the workmen are not satisfied with some phase of the terms of employment or with some feature of the rules imposed upon them, or have a complaint against any particular foreman or other person in the establishment, or if an individual workman has some personal grievance, such conferences would bring the matters complained of to the attention of the management at an early stage, before the workmen have become demoralized by brooding on the subject, and, if dealt with promptly and fairly, there would be less danger that a small grievance would lead to serious trouble. Through their representatives, the workmen could be taught sound economic principles such, for example, as the fact that good wages and national prosperity as well depend upon efficient service and large production. They could be made to see that if it is reasonable that wages should respond to improved conditions of business, it is equally reasonable that if business declines, wages should be reduced. There would be an opportunity that would otherwise not exist to present to the workman the reasons why, from the point of view of his own selfish interest as well as that of the public good, a reduction of the hours of labor below the point of maximum production consistent with the health and reasonable comfort of the worker is a fatal mistake. At and by such conferences the workmen should be encouraged to make suggestions as to the improvement of shop methods, large or small. Many workmen are unquestionably capable of real help in this way. They could be made to realize that they were a vital element in the work whose cooperation in all ways was needed and expected. To such suggestions they would surely be inclined to respond.

It would seem that if in every one of the industrial establishments of the country a definite effort was made on the part of the management to bring about directly or indirectly such personal contact between the employer and employee as would result in a frank discussion of the employment relation and those matters concerned with the enterprise in which the employees are necessarily and vitally interested, and a definite recognition of the workmen as essential factors in the enterprise, antagonism might be eliminated and relations of loyalty and confidence established to an extent that would be most fruitful in good results.

It goes without saying that nothing can be accomplished by mere machinery. The right spirit must be developed on both sides; but it is unreasonable to suppose that it is impossible to develop that right spirit. In any event, it would, in my opinion, be a red-letter day not only for industry but for the public if all the employers of the land were to start in to bring about an improvement in employment relations by the very simple expedient of working, each in his own establishment, to see what could be done by personal contact between employer and employee to inspire confidence, harmony and coöperation.

Selection of Employees' Representatives

In any such shop organizations as those above referred to, it is of vital importance that the representatives of the employees should be honestly chosen, and chosen from among the employees themselves and not from the labor unions. Otherwise, the labor unions would find it necessary to enlist as members only a small portion of the employees in any given establishment and that minority, acting as a unit, would be able to elect walking delegates or other members of the union as representatives of the whole body of employees. If that happened and the employer was obliged to meet these labor-union agents as the representatives of his men, his fate would be sealed. An "open shop" employer would surely find himself forced to the union shop, first, by the pressure of the negotiations, and, second, by the moral effect upon his own men, exaggerated by the skillful way in which the labor unions would utilize the fact that they and they alone through the prestige of their union were maintaining the rights and promoting the interests of the employees.

It is futile to contend that the employees in any given establishment cannot find among their own number men who are quite competent to represent them fairly in conference with representatives of the employer. In every shop there are many workmen quite capable of presenting their own views and those of their fellows in a most effective fashion. Such men are sure to be elected by the workmen as their representatives.

Advantages Obtained from a Well-Organized Employment Department

Another direction in which effort should be made by the management in each individual establishment to better the conditions of the employees and improve the employment relation is in the matter of unemployment and of hiring, placing and discharging. Unnecessary unemployment is one of the most serious incidents of modern industry. It undoubtedly has much to do with the discontent of the workmen. The subject has been given much less careful attention than its importance deserves.

Here again much can be accomplished by intelligent management in the individual industrial establishment. Nothing could be more absurd than the hiring of men without a careful examination into their fitness for the particular job for which they are hired. Their mental, physical and moral qualifications should be studied and they should be assigned to work in view of the qualifications which they are found to possess.

When employed there should be every certainty that they are not to be discharged without due cause. If a man proves unfit for the work to which he is assigned, an effort should be made to find other work in the establishment for which he is qualified. Every employee should feel assured that the management proposes to keep him at work during good behavior if it is possible to do so.

In this matter of hiring and discharge, it is not safe to trust the foremen unless they are carefully supervised. There is no doubt that one of the most serious needs in our industries is a better education of the foremen and like subordinate officials and such supervision that they are unable to make the mistakes and do the harm that the wrong men can easily do in such positions.

Experience seems to show that one of the greatest economies that can be practiced in an establishment of fairly large size is the organization of a department which shall be devoted to the hiring, placing and discharge of men on definite and scientific principles. Moreover, if workmen feel secure in their jobs, except for their own definite failure to do good work, they must inevitably have a greater feeling of content and a stronger inclination to serve well the employer who has given evidence that he proposes to continue them in his employ.

That stability of employment is a matter of the utmost consequence to the employer as well as to the employee, is illustrated by the fact that not infrequently the management of an establishment finds that it must hire a thousand or more men really to add two hundred to its force. The cost of hiring and training all these men is a severe burden on industry.

In this same connection it is also clear that the management of our industries should give far more attention than is given at the present time to reducing irregularity of employment. To this end much may be done in each individual establishment by way of spreading out the work and declining to go to extremes in pushing production in good times and reducing it when the market is bad. If employers as a whole were to take up the problem seriously and endeavor to work together for its solution, there is no doubt that cyclical as well as seasonal extremes of undue activity and undue depression could be to a large extent minimized.

Such schemes as profit sharing, bonus payments, the acquisition of stock by the employees and other devices for increasing the return to the wage earner are worthy of careful consideration; but in each case in view only of the conditions of the particular establishment. It may well be that in some instances the management may determine that one or the other of these plans is likely to give to the workmen a more permanent interest in the enterprise and therefore to remove antagonism and develop loyalty.

WAGES AND WHAT SHOULD DETERMINE THEM

It seems probable, however, that the workmen for the most part are chiefly interested in the pay which they receive at stated intervals. While they should be encouraged to save and make investments, it may well be that in most cases they would not be greatly influenced by the chance of return at some period which seems to them remote.

While there is no doubt that the law of supply and demand will always, to a large extent, control in the matter of fixing wages, those engaged in industry are, I think, becoming more and more convinced that as a practical matter the operation of this law may well be modified in view of other considerations. In a normal industry each workman should surely be able to earn enough to live comfortably in accordance with the standards of a right-minded man of his position in life, and to save for a rainy day and for old age. If he cannot earn as much as this, he should not remain in that industry. If the industry cannot pay the normal workman this amount, it should not, in the long run, survive. It moreover seems clear that efficiency and loyalty should be recognized in the wages paid; also that the wages might well to some extent reflect the prosperity of the individual establishment.

In this matter also the burden is upon the management of each individual establishment to deal fairly and justly with its workmen in view of the conditions characterizing that establishment; but it is certain that more satisfactory results will be attained if consideration is given to the ideas of his workmen on the subject and an effort is made to make them understand why the wages proposed or paid are reasonable and proper.

So as to hours of work. There can be no possible reason for a fixed period for all industries. In each it should be determined by scientific study what number of hours a day will make possible the maximum production consistent with the health and reasonable comfort of the workmen. Even in the same industry the hours of work may well vary in different establishments. The locality, climate, general environment and living conditions are important factors in determining how long one may work without sacrifice of health or comfort. There is no comparison in this regard between, for example, the conditions of men in a shoe factory in the country and those similarly employed in a shop in the heart of a city like St. Louis.

Here again the solution of the problem is one for the individual establishment, to be determined by the management, preferably after conference with the employees who are very likely to assent to a sound conclusion when the conditions are fully explained to them.

There seems to be no doubt that overtime work under present conditions cannot be justified except in the case of a real emergency. As we all know, overtime work is insisted upon by many employees as a device for getting a larger return for their services. This is mere pretence, overtime being used as a plausible camouflage for an unstable and deceptive situation.

Much might be said as to the spirit of our institutions and how inconsistent with that spirit would be the domination of the industries by the labor unions; while, on the other hand, the "open shop" and the personal dignity of the relations between employer and employee, which is reflected in the "open shop," illustrate perfectly the principles of individual freedom and of fair play which are at the basis of our economic as well as of our political and social life.

EMPLOYERS MUST DEAL OPENLY AND FRANKLY WITH THEIR WORKMEN

If I am right in my views, the opportunity for bringing about a satisfactory feeling between employers and employees, by definite and conscious effort on the part of the management in the individual shops, is so great that it seems to be the plain duty of every individual employer throughout the country to adopt the principle of dealing openly and frankly with his workmen in all matters which need to be understood on both sides if relations are to be cordial.

Management can never be asked to sacrifice its function of judgment and direction. If the so-called "democratization of industry" means the contrary of this, it is nonsense. The workmen would be the very first to recognize that ultimate control must be with the employer. Naturally, however, they cannot be satisfied if no opportunity is given them to state their point of view as to matters which are of the utmost importance to them in their life's work.

It is obvious that such relations as should exist between management and workmen are only possible in an establishment which is not tied up with the trade or labor unions. There alone are the workmen free from outside influence, which may be and often is used to stimulate antagonism and to breed dissatisfaction as well as to reduce efficiency.

EFFICIENCY AND PRODUCTIVE POWER GREATER IN THE OPEN SHOP

In the "closed shop" it is in effect the labor union which negotiates with the employer as to wages, hours of labor and working conditions and its negotiations are carried on from the point of view of the labor union and not of the men; although even in a "closed shop," under some conditions, "shop councils" or meetings between the management and the employees would be possible. There are not, however, likely to be such relations in the "closed shop," particularly as the American Federation of Labor, at its annual convention in 1919, definitely resolved that "we disapprove and condemn all such company unions [works councils, etc.] and advise our membership to have nothing to do with them." The resolution further stated that "we demand the right to bargain collectively through the only kind of organization fitted for this purpose, the trade union." In the steel strike the "abolition of the company unions" was one of the fundamental demands of those promoting the strike.

It seems incredible that the people of this country, as a whole, if they really understood the situation, should not stand firmly for the "open shop," as distinguished from the "closed shop," not only because of the greater efficiency and productive power of men who are not bound by union rules but also because, in the "closed shop," personal and direct relations between employer and employee without outside interference are practically impossible.

Of course, an employer should be free to allow his shop to be organized and to deal with the trade unions, as representing his men, if he is willing so to do, just as he should have the right to work through a closed non-union shop; but certainly there should be no moral pressure brought upon him to force such action on his part.

There are many other questions which some regard as of great importance in relation to the present labor conditions. For example, how far if at all should the state interfere by the compulsory arbitration or by way of conciliation and mediation in labor difficulties? Something of the sort must come if labor-union domination is to characterize the future of industry.

On the other hand, if the development is on such lines that the employer and employee in each individual establishment take up in a sane fashion the problem of fixing the employment relations on a fair basis, it may well be that labor difficulties will be so reduced that no scheme of arbitration or conciliation would be worth while. Certainly, no one can look forward without perturbation to the interference of such boards. Experience has shown their incapacity and the unsatisfactory results of their efforts.

Another matter which would be of vital importance if labor-union domination were to prevail would be assurance of the responsibility of the unions and of their legal obligation to carry out the agreements that they make.

At the present time the labor unions are practically immune against attack even for their crimes. They are not clearly responsible to those whom they unlawfully injure. They may not be held on the contracts that they make. Their compliance with an agreement is almost altogether a purely voluntary act on their part. If they were to become the representatives of the men and were to act for the men in a substantial part of the

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Systems for Mutual Control of Industry

By WILLIAM L. LEISERSON[1], ROCHESTER, N. Y.

IT is difficult for us to change our conception of those conditions and relations as we have learned to know them from years of experience, said Dr. Leiserson, in introducing his discussion of shop committees, works councils and the coöperative or industrial democracy plans by which employers propose to give their employees some voice in the control of industry, as contrasted with trade-union collective bargaining by which organized wage earners attempt to force employers into a system of joint control of wages and working conditions.

"This is particularly true," he continued, "of conditions of employment and the relationship between employer and employee." He pointed out that the world war and the shortage of labor since the armistice was signed have materially changed the status of the employee, and that however much the employer may realize the changed industrial conditions he finds it immensely difficult to conceive of his employees as people who do not have to obey his orders, but instead have to be consulted in any action that may affect them.

"To talk about mutual or democratic control of industry or to establish plans for coöperative or industrial democracy without a clear realization of the revolution that has taken place in the status of the wage earner can lead only to confusion and to failure of the plans for mutual control of industry," Dr. Leiserson asserted. He then compared the present situation with that in the fourteenth century in Europe when an industrial revolution brought on by the Black Plague and characterized by much the same industrial ills that we suffer now, resulted in changing the status of the laborer from that of a serf to a wage earner. He then traced the history of the labor movement in this and other countries, covering much the same ground as in his former address, published in the November 1919 number of MECHANICAL ENGINEERING, p. 884, and continued: "In a democratic country with rising standards of living and large numbers in what we call the middle classes there is no great danger of labor completely dominating the situation and becoming the only masters of industry. But just because we are a democratic country with rising standards of living, and because our wage earners are now approaching the status of members of the middle class, we cannot permit employers alone to remain the masters of industry as they have been in the past. There is more danger of Bolshevism from the employers' side in this country than from the workers' side. Dictatorship by the plutocrat is worst than dictatorship by the proletariat. We are warned against the latter and the people of the United States will never permit wage earners to take over our industries and control them absolutely. But we are not warned against the employer doing the very same thing and there is great danger that in our fear of Russian Bolshevism we will be led to side with those employers who attempt to fortify themselves in their old positions of sole and only masters and dictators of industry. Only the public through its regularly constituted government can be permitted to be masters of industry. Both employers and employees must be servants of the public. The mistake we are likely to make in dealing with this problem is to assume that because industrial democracy necessarily involves an organized labor force capable of acting as a unit through its representatives, therefore every organization of working people in industrial plants is an example of industrial democracy. As a matter of fact, however, a study of the employees' organizations now in existence will show that they classify themselves into three general groups and that the element of democracy is present in only two of these groups, but not to the same extent in each.

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> *"Labor management means control, discipline, an industrial organization held together by rules, orders and authority, reaching down from an executive head at the top. Collective bargaining implies a questioning of that authority. It is based on the principle that an individual employee cannot effectively question the authority of the management. It says there must be no rules or orders affecting the lives and welfare of the wage-earners without the consent of those who must obey them.*
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> *"Here we have the age-long problem of reconciling authority with democracy. Law, order, government, we must have in industry as in all other human institutions, but the day of autocratic control is gone, at least in all western civilizations. To maintain law, order and government in the industries of these western countries there must also be democracy, the consent of the governed. Without such consent, without such democracy, our industrial governors find themselves unable to control their organizations, to have their laws, rules, regulations and orders obeyed. This is the essence of the industrial problem today."*
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> *WILLIAM L. LEISERSON.*

EMPLOYEES' ORGANIZATIONS

"The first group of employees' organization plans may be called shop committees proper. These are merely advisory organizations of the working force selected either by the management or by the employees for the purpose of conferring with the foreman, with safety directors or personnel and service managers regarding various problems related to working conditions in the plants. The matters with which these committees are concerned are primarily safety and welfare work with a small number trying to extend their activities to include grievances. Although these committees are constantly hailed as examples of industrial democracy, they involve no element of collective bargaining or joint control over terms and conditions of employment. Complete authority is centered in the management, the committees merely giving advice and suggestions which may or may not be accepted by the management. The powers, functions and methods of operation of these committees identify them with the service work of the plants rather than with problems of bargaining, of wages, hours and shop discipline.

"The second group of organizations may be called 'employers'

[1] Chairman, Labor Adjustment Board.

Presented at the Annual Meeting, New York, December 2 to 5, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in slightly abridged form. All papers are subject to revision.

unions.' In this group are included all those plans which either explicitly say, as does the Midvale Steel and Ordnance Company plan, 'We recognize the right of wage earners to bargain collectively with their employers . . . . .' or which by implication recognize the principle of collective bargaining as do the plans of the Bethlehem Steel Company, the International Harvester Company and the Colorado Fuel and Iron Company. The employees' organizations in this group represent a long step in the direction of industrial democracy, for they involve getting the consent of the employees who are the governed in industry, in the making of industrial laws. As political democracy provides for the consent of the governed in the state, so industrial democracy will provide for the consent of the governed in industry. The difference between these 'employers' unions' and the ordinary unions known as 'organized labor' is that the former are initiated by the employers; they are confined to one company rather than connected with a national organization of employees and the management is not excluded from the meetings.

"The third group of organized workers are the ordinary labor unions, and they usually involve written or understood agreements between national unions of the employees and individual firms or associations of employers. The agreements invariably cover wages and hours and usually working conditions as well. The Hart, Schaffner & Marx plan and the contracts of a number of firms in Rochester with the Amalgamated Clothing Workers are examples of agreements with individual plants, while the conventions of the United Mine Workers and Coal Operators, and the Joint Boards of Control in the needle trades in New York City may be cited as examples of agreements with associations of employers.

"However much the employer whose workers are included in the third group may object to the principle of collective bargaining, he understands thoroughly that his agreement with the union involves that principle. In the second group, however, in the plans we have called 'employers' unions,' there is not always this clear understanding on the part of the employer of what his employees' organization involves. Where the principle of collective bargaining is present only by implication as is true in practically all the plans except that of the Midvale Steel Company, it quite often happens that the employer does not realize that his plan involves this principle. The employees, however, usually assume it does not mean anything unless it gives them the opportunity to bargain collectively with their employers. It is hardly necessary to point out that any misunderstanding like this of the purposes of a plan of employee representation is likely to cause trouble between employer and employee."

Collective Bargaining With Organized Labor

Dr. Leiserson then discussed the features of collective bargaining which he believed would contribute to its success, and those which would doom it to failure. He contended that the vast majority of such dealings between employers and employees must be carried on by organized labor for the reason that organized labor is growing very much faster and stronger than the competing movement of company organizations launched by the employers. "During the past four years," he said, "when the works council movement has made such great headway, very many more wage earners have joined the regular organized labor movement than are included in all the company plans put together." Also, that inasmuch as there can be no permanent raising of the status of the wage earners unless the whole industry is affected, "there can be no effective bargaining, particularly in a competitive industry, unless it be conducted on a national scale."

"Works councils, or a union confined to one plant or a few plants, can do little to give to the wage earner a larger share of the returns from industry as compared with what capital and management has been receiving. And this is what collective bargaining and democracy in industry aims at.

Competitive conditions will hold the single plants down to the level of the industry as a whole. Before the distribution of wealth produced by industry can be improved to give labor a larger share, collective bargaining on a national scale covering all markets, must be established. It is because the wage earner sees this that he is so easily led away from company unions by a national organizer.

"Labor management means control, discipline, an industrial organization held together by rules, orders and authority, reaching down from an executive head at the top. Collective bargaining implies a questioning of that authority. It is based on the principle that an individual employee cannot effectively question the authority of the management. It says there must be no rules or orders affecting the lives and welfare of the wage earners without the consent of those who must obey them. It joins the members of the industrial organization into a union and forms a democratic legislative body for the purpose of giving to those who have to obey the laws of industry a voice in determining what those laws shall be. Labor management implies power, authority or lawmaking in the hands of the employer. Collective bargaining means democratic representation in the process of that law making and democratic control of the exercise of that industrial power or authority.

"Here we have the age-long problem of reconciling authority with democracy. Law, order, government, we must have in industry as in all other human institutions, but the day of autocratic control is gone, at least in all western civilizations To maintain law, order and government in the industries of these western countries there must also be democracy, the consent of the governed. Without such consent, without such democracy, our industrial governors find themselves unable to control their organizations, to have their laws, rules, regulations and orders obeyed. This is the essence of the industrial problem today."

An Attempt to Secure Democracy and Efficiency in the Clothing Industry

Dr. Leiserson then described an industry where an attempt has been made to put labor relations on a democratic and efficient basis, where collective bargaining with a Union prevails, and where the administrative machinery necessary to make collective bargaining work satisfactorily, has been created. This is the clothing industry, which employs over 200,000 people. It has four great market centers, New York, Chicago, Rochester and Baltimore. In all of these markets it is now almost completely organized and only a few firms are outside the agreement between the Clothing Workers Union and the employers' associations.

Dr. Leiserson said that both sides are organized, and that there can be no real collective bargaining if only the workers are organized and enforce their will on the employers, any more than when only the employers are organized. "In each of those cities," he said, "there is an agreement between the Employers Association and the local branches of the union. The agreements fix minimum wages, establish a working week of forty-four hours, provide for open or preferential shops, except with one association which granted a closed shop, prohibits strikes, and restricts the employer's rights to discharge by making him give a good reason for every dismissal.

"The local unions of the various trades in the industry elect delegates to a central body, known as a Joint Board. This board employs managers and deputies whose business it is to represent the employees in handling their grievances. In each shop the employees also elect representatives called Section Chairman and Shop Chairman.

"On the employers' side there is a similar organization. Each of the large plants employ a labor manager, who has charge of all bargaining and labor control, as well as employment and service functions. For the smaller plants, the employers' association employ labor managers who perform the same duties for groups of employers. In New York and Chicago, there is a chief labor manager employed by the association, and all the

(*Continued on page* 82)

What May We Expect of Profit Sharing in Industry?

By RALPH E. HEILMAN,[1] CHICAGO, ILL.

THAT the subject of profit sharing is not one which is new to this country but dates back to the early 70's when there was a very widespread interest in the whole subject of profit sharing, was pointed out by Dean Heilman. Many experiments were introduced at that time and profit sharing was heralded as if a panacea for all industrial problems. Most of these experiments were soon abandoned, however, and profit sharing came to be regarded as a subject of interest mainly to the social reformer or theorist and of little interest to the business man. In the last few years, however, there has been a marked increase in the attention paid to the subject, which justifies a reëxamination of the profit-sharing plan in the light of modern business practice and methods.

What Constitutes Profit Sharing

"At the outset," said Dean Heilman, "let us ask ourselves in what really consists profit sharing, because as a matter of fact there are many plans widely heralded throughout the country as profit-sharing plans, which do not, in any real sense, embody the fundamental principles of 'profit sharing.'

"Profit sharing is an agreement between an employer and his employees whereby the latter participate in some way in the profits of the business, either of the business as a whole or of some unit part of the business. This participation is on a predetermined basis definitely known and established. With that conception of profit sharing in mind, the question is asked, 'Why should any employer, firm, or corporation wish to introduce an arrangement of this kind and voluntarily share a portion of its profits with its employees?'" Continuing, the speaker discussed the various aspects of profit sharing as a business arrangement, and said in part:

"The typical wage earner seeks neither philanthropy nor charity, and likewise the employer does not wish to distribute gratuities to his employees. Therefore, if profit sharing is to justify itself, and to be introduced on any wide scale, it must be as a business arrangement which will prove mutually advantageous and profitable, both to the employer and employees.

Business Reasons For Installing A Profit-Sharing System

"What, then, are the business reasons which would lead a firm to introduce this profit-sharing system and what are the advantages which its introduction would bring about? In the first place, it is claimed that profit sharing will increase efficiency and output.

"But only to a certain extent is this true, and only under special circumstances and subject to special limitations; in other words, generally speaking, more effective results are obtained from labor if compensation is on the basis of the measurable results of each individual so that he will be induced to put forth his best efforts. It is frequently difficult, if not impossible, however, to ascertain and apportion the results of the individual worker, since there are conditions under which labor presents a joint product, in which it is impossible to compute or disentangle one individual's work from the mass production of all the workers.

"Under these circumstances profit sharing may prove desirable and prove an additional incentive to increase production far in excess of what would be secured with the flat hourly rate. For example, consider the Procter & Gamble plant at Cincinnati, which for 20 years has had a thoroughly successful profit-sharing plan in effect. Here the men are engaged in shifts, keeping the huge vats of soap in continuous operation, so that it would be impossible to separate the work of one shift from that of another and award any one shift over and above another.

"The same is true in most lines of work in the gas industry, which probably accounts for the fact that in England profit sharing is in vogue in connection with some of the gas plants in that country. Where work can be definitely measured, the best plan, probably, is to pay the individual on a basis of individual results. But where work cannot be definitely measured, then the profit-sharing plan may prove an effective supplement or addition to the regular flat-time wage.

"Secondly, profit sharing may be introduced for the primary purpose of promoting permanency and stability among the employed staff and as a consequence reduce the labor turnover. Ordinarily reliance is placed on what may be called two 'deferred features' to accomplish this result. The first of these is the preliminary or qualifying period which an employee is required to serve before he can participate in the profits. This may be six months, or two years as in the plant of the Dennison Manufacturing Company, or three years as in the case of the Burt plant, or seven years as in the case of the Sears, Roebuck & Company plant. Reliance is placed on this qualifying period to hold the employee until its expiration so that he may qualify to share in the profits.

"The second deferred feature is that the profits are only to be issued at stated periods, say, once in six months, or at the end of the year, with the proviso that if the employee leaves the service of the company before the profits are distributed, he foregoes his participation in the profits. Reliance is placed on this feature to hold the employee until the end of each period.

"The power of profit sharing to hold employees and promote stability of employment depends on the question as to whether the profits paid represent a net addition to the full current-market wage paid to similar classes of workers in other industries. If profit sharing is used to depress wages the employees would not desire to accept the profit-sharing plan, and it would defeat itself in that way; but if the profits to be paid represent a net addition to the going current-market wage, it has been demonstrated that in many cases the introduction of profit sharing will tend to reduce the labor turnover and promote permanency and stability among employees.

"Again, profit sharing is sometimes introduced with the hope that it will promote industrial peace, that it will do away with industrial strife, industrial disputes and strikes, and that thereby a larger degree of wholesome and cordial industrial relations will be promoted between employer and employee. Profit sharing has possibilities in this direction, but they have been exaggerated. It is significant that profit sharing is not now, and never has been, one of the demands for which organized labor has striven, and that in some instances strikes have immediately followed the introduction of profit sharing. Instead of giving an ironclad guarantee to industrial peace, profit sharing may give rise to new causes of controversy, as for example, controversy over the percentage or amount of profits which should be shared, or the method by which it should be computed.

"Nevertheless, under certain circumstances profit sharing may be expected to promote wholesome industrial relations, but if it is to be introduced for this purpose the most promising and fruitful field for its application is in those plants which have already introduced so-called shop committees, or internal unions of employees, or works councils. For here any degree of management sharing which is accorded to the employees may go hand in hand with profit sharing, the one strengthening and reinforcing

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[1] Dean, School of Commerce, Northwestern University.

Abstract of an address presented at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers.

the other, promoting a better understanding and a more wholesome, cordial and peaceful relations.

VALUE OF PROFIT SHARING IN PROMOTING EFFECTIVE MANAGEMENT

The most important purpose for which profit sharing has been introduced, in the opinion of Dean Heilman, is to promote effective management upon the part of managerial executives, semi-executives, junior executives, and salaried employees all the way from foremen or sub-foremen up. Although the great bulk of the literature on profit sharing deals with its applicability to the rank and file of the wage-earning group, the most promising and fruitful field for the application of profit sharing rests with the salaried class, those holding the positions of larger importance and larger responsibility in business. People of this character ordinarily are paid a flat salary, because so far we have evolved no other satisfactory method of compensating this class of workers, but we are beginning to realize the inadequacy of a flat salary even for those who hold executive, semi-executive, or minor executive positions. The flat salary usually fails to draw forth from a man the best exercise of his abilities, and it is not always the case that salaried employes find incentive through the hope of advances do not come as fast as expected, or when the salary limit for the job is reached, there develops a lassitude, and often a lurking resentment in the back of the employee's mind which mars his efficiency.

One of the most important questions at the present time is how best to compensate those hired to manage an industry, because at the present time, in larger-scale industries, even those who occupy most important managerial places, are to a very considerable extent hired employees. A partial answer to this question, according to the judgment of the speaker, lies in the application of profit-sharing schemes or restricted profit-sharing schemes, especially for those who occupy the positions of larger importance and larger responsibility in these business organizations. Dean Heilman said:

"This principle has already been recognized by a considerable number of business organizations. Two organizations which have successful profit-sharing plans, limited to the small upper group, are the Dennison Manufacturing Company, which includes about 200 employees out of a total of 3,000, and the Solvay Process Company, which divides the executive heads of its departments into three groups according to their responsibilities. Then there is the plan of the Studebaker Company, grouping the employees into four groups, in direct ratio to their responsibility and classification. The same thing is true of the Dold Packing Company, which has its executives classified in two groups. A number of other companies might be mentioned which have their managerial employees classified into groups for profit-sharing purposes.

"This principle has been applied by the largest department and merchandizing establishments in the country to the department heads—in the latter case, the special or additional compensation generally takes the form of a percentage, not of the total operations of the business as a whole, but a percentage of the profits simply of the particular department of which the individual happens to be in charge.

EFFECTIVENESS OF PROFIT SHARING AS AN EFFICIENCY DEVICE

"The most important conclusion in this whole subject is that effectiveness of profit sharing viewed simply as an efficiency device and peace arrangement for the purpose of increasing profits by sharing them, is in direct ratio to the rank of the participants and in inverse ratio to the size of the participating group. Stated in another way, the effectiveness of profit sharing purely as an efficiency arrangement is greatest among large groups, or if applied to the rank and file of wage earners, is greatest among small groups.

"What is the relation," asked the speaker, "of the effectiveness of profit sharing to the rank or responsibility of the participant? In the first place, the higher the rank, the greater is the opportunity which the individual has to exercise an important influence on profits. A purchasing agent, for example, by one shrewd purchase, can exercise a greater influence on the total profits of the business than a workman in the course of a year, no matter how faithful he may be in the performance of his duties.

"In the second place, the greater the responsibility, the easier it is for the employee to see the relation of his efforts to the profits of the business. It is easy for the sales manager to see that if he finds a new market for the product of the concern, he will thus increase profits. But it is a difficult thing for the elevator man to see that he can so run his elevator that he can produce any great increase in profit.

"In the third place the managerial or executive group are more familiar with business vicissitudes and uncertainties than the rank and file. This has an important effect when you come to a lean year. Many profit-sharing plans have gone on the rocks when they have struck a lean year. When the profits are small or non-existent, it often happens that the employee who has worked as hard as he did the previous year is suspicious that some advantage has been taken to deprive him of his portion of the profits. But in the case of the managerial employee he has foreseen the conditions, is familiar with the market conditions and market fluctuations, and instead of losing confidence in the profit-sharing plan, he may gain a larger sense of partnership in the enterprise.

"What is the relation between the effectiveness of the scheme and the size of the participating group? It would seem that a profit-sharing plan would operate successfully for the rank and file of wage earners only when applied in a small or medium-sized shop, because the larger the group of participants, the more difficult it is to educate them in the essentials of profit sharing, and the larger the group, the less effect each one can exercise on profits.

"These conclusions are verified by the history of profit sharing. In nearly every scheme of profit sharing for the wage earner which has been abandoned, it will be found that it was a scheme which included a large number of the rank and file indiscriminately. Also many plans have been abandoned so far as the rank and file are concerned, but retained so far as the managerial and salaried group are concerned. Moreover, although many of the profit-sharing plans introduced for the benefit of the managerial group have been modified, none, so far as I know, have been abandoned as failures.

"Profit sharing is not a social panacea," concluded Dean Heilman. "It will not solve the vexing problems which arise between employer and employee. It will not prove a substitute for good management on the part of the corporation, nor will it prove a substitute for the wage system. But within the wage system it has a place, a real place. In my judgment, we are destined to see a much wider and a much wiser use of profit sharing than in the past."

Although the Bureau of Standards dropped most of its experimental work upon the use of metal to replace wood in airplane construction, the future of metal construction appears promising, especially as the need for a fire-resisting airplane becomes more generally understood. To avoid the difficulty which has been found in designing sheet metal parts so as to secure sufficient compressive strength one engineer has devoted much time and study to the use of steel tubes. A single metal tube has much less strength for its weight than a beam designed to concentrate most of the material in the flanges which are subjected to the higher stresses. The tubular design uses several small cold-drawn steel tubes for the flanges which are connected by diagonal latticing of tubes of the smaller diameter. It is also possible to join tubes by inserting a snugly fitting tube of smaller diameter into another for a distance which will give satisfactory strength. Methods of fastening the two tubes together readily present themselves. It is believed that encouragement and assistance given to metal construction by this Bureau is now about to result in material improvements which will come into general use.

The Future of Aviation

Landing Fields and Wireless "Beacons" the Great Need—New Inventions Less Important—Future Wars will See Armored Planes and Aerial Torpedoes

By COL. E. A. DEEDS,[1] DAYTON, OHIO

ON Thursday evening, December 4, at the Annual Meeting of The American Society of Mechanical Engineers, the night when the members of the Society and their friends gather for their annual reunion and lecture, Col. E. A. Deeds, the first speaker of the evening, was greeted by a large audience, to which he presented in a most entertaining manner some of the possibilities of the future of aviation both for military purposes and in its commercial applications. Following Colonel Deeds, Col. Thurman H. Bane, Chief of Engineering, Division of Air Service, and commanding officer of McCook Field, displayed a series of lantern slides and moving-picture films of McCook Field and the work accomplished there. These pictures were released by the War Department for this lecture for the first time and a number of the views are reproduced in the engravings on the following pages. The remarks by Colonel Deeds are here given in abstract and present some of the most interesting facts which he brought out.

"When any one talks on the future of aviation we indulge in flights of the imagination and we measure his ability as a speaker by the number of thrills he can give us as he pictures the wonderful things which are likely to happen. This places one who knows the industry at a disadvantage because the great thrills of aviation have already taken place. I would rather, for instance, take up tonight the work of the Wrights and the beautiful story of how these two brothers worked together; how their savings were expended and how their sister readily gave hers, the experiences around the fireside, and the sacrifices made—a story which will never be duplicated. It is one of the finest examples of courage and originality, interwoven with family devotion and sacrifice, which will always stand as one of the great achievements of American invention.

"Then if we pass from the date when Orville Wright made his first flight in 1903 to the time of the war, we will find a struggling industry, many sacrifices, and here again, events that never will be duplicated.

"The war itself gave a tremendous impetus to aviation; and when we get enough perspective and are far enough removed from it so that the public will be able to discern between the patriotism and performance on one side, and propaganda and politics on the other side, there will be found a real record of achievement, more potent and more inspiring, probably, than anything the future can give us, at least for some years to come. The short period of the war gave aviation a greater impetus than it would have received from fifty years of old peace-time experiences along these lines. There was created during that time an organization out of nothing, practically, that provided 16,852 airplanes, 40,420 engines, 642 balloons, several hundred flying boats and many accessories that had to go with them—a tremendous undertaking, and accomplished with fairly good success.

"There were such accessories as the wireless telephone, the oxygen apparatus, so that the aviator could breathe at high altitudes, the bombs that went on the planes, the gun sights, the electrically heated clothing, machine guns, fixed guns, synchronized guns, 37,000 of which were provided, the pyrotechnic accessories that went with the airplanes, the instruments of navigation and others which created an industry in which there were approximately 300 concerns involved, and over 250,000 men working on apparatus for the Air Service when the armistice was signed.

"Along with this development came the need for supplies—the demand for raw material. There was particularly a large demand for spruce timber. There were 27,000 or more boys in uniform out on the coast who were engaged in supplying the Allies with spruce for the building of airplanes, and because of their activities we were never compelled to shut down a single factory in this country or abroad, because these men supplied all the lumber that was required. The chemical industries supplied the dope that went on the wings, oil, and things of that sort, and there is a long list of industries which furnished material and supplies to advance the work.

"During these eighteen strenuous months there were developed and produced 15,576 Liberty engines, representing a total of more than 6,000,000 hp., an accomplishment which history unquestionably will put down some day as one of the great mechanical achievements of the war. The Liberty engine was the first across the Atlantic, the first across the Continent, and by the sheer force of its inherent merit, it has put itself among the foremost engines of the world. It was a great accomplishment, done with great credit to the manufacturers, who coöperated in a wonderful way to make that work successful."

Colonel Deeds spoke about what the boys themselves did, stating that twenty-two thousand were trained to fly in this country, and they flew approximately 66,000,000 miles in their training alone, with the splendid record of only one fatality to every 200,000 miles, or the equivalent of eight times around the earth. This is an indication of the comparative safety of this form of transportation. That thousands of boys from all parts of the country, brought into camp under military discipline, should go through the most perilous part of flying, that of training, with the loss of only one flier in a distance which is equivalent to flying eight times around the world, is an achievement to be proud of. With regard to the record of the boys in France, he said: "The knights of old cannot picture anything more dramatic than the young men who went out in these powerful machines, going out alone, going up 10,000 or 15,000 ft. out over the enemy lines, and meeting in hand-to-hand combat, as it were, the enemy. Never will a page be written in history that is as brilliant and thrilling, because in future wars we will look on these things more as a matter of course, even though they will take a more important part.

"There has been during this war period a record of accomplishment which is more potent and more inspiring in many phases than anything the future can give us for a long time. That does not mean, however, that there is not a great future for our aviation. But it is going to have this disadvantage, that it will be misunderstood and partially discredited by the public. Because the airplane has not accomplished all the spectacular feats which were prophesied for it, the public is now inclined to underrate the possibilities of aviation. Too much credence should not be given to those who picture the air full of airplanes on various missions, moving on our hotels in flocks, surrounding our office buildings, and carrying passengers to their occupations. The future of aviation is bright enough viewed from a practicable standpoint."

Looking to the future the speaker predicted that the line of development in military aviation will take several forms. There will be armored airplanes, protecting the pilot and observer, and limited, of course, in size and thickness of armor, which will be made of more highly specialized and better-treated steel. Larger planes should be developed, planes carrying cannon and more guns, so that there will be no blind angle. These planes would not maneuver, but go directly to their objective. The ground-strafing machine, armored beneath, with machine guns pointed down to cover the trenches, will undoubtedly create havoc.

The ability to reach high altitudes is another line of develop-

[1] Chief of Equipment Division of Air Service during the early development of the air program of the war. Mem. Am. Soc. M. E.

ment that is vital because, as Colonel Deeds put it, "About the only safe place in this game is to be up where the other fellow cannot get." That means that the air fighters of the future will have to be able to do their work at an elevation of 40,000 ft., in a temperature 50 deg. below zero.

Then, higher speeds will be necessary. Approximately 160 miles is the maximum speed today, not the advertised speed, but *the speed*.

There is also the aerial torpedo, that is, the pilotless aeroplane, that will go out 100 miles and then shed its wings and drop the whole fuselage, accurately hitting a target the size of a city.

"That," said the speaker, "is not a dream, and the problem was so well developed during this last war that there was a group of young men who were sorely disappointed when the armistice was signed, because they had expected to go over and discharge these pilotless machines against the enemy and create havoc in his ranks." That is a line of development which is sure to come.

There is the possibility of wireless control, too, but it has many difficulties, and may not be practicable.

The line of tactics that ought to be used by the military aviation division is a very important thing, and involves better communication, better relationship with other branches of the Army, the independent work to be done by the aircraft—a whole new line of work just touched upon by the war which must be interwoven now with our military tactics in every way. This can be done only by thorough, painstaking, experimental and development work. It is going to require the services of the engineer in the laboratory and of the flier in the field. Time, the greatest element in all of these undertakings, the thing we could not get in this last war, will be required to put this future aviation where it belongs in this country; that is, time enough for these engineers to do their work.

After outlining these various lines of development in military aviation, Colonel Deeds took up the subject of commercial aviation and said in part:

"At the present time the risks are too great, and the expenses too high, for private capital to go into commercial aviation. Government aid must be injected in some way into the commercial side of our aviation, if any progress is to be made. The worst thing that could happen to commercial aviation would be to place the entire responsibility upon the Government, but there ought to be some way worked out whereby moderate sums would be appropriated each year, to assist the commercial side of this industry until such a time as it can take care of itself.

"The most important thing for commercial aviation today is the simple thing of landing fields, because until we get them we can have no so-called commercial aviation. Municipalities should set aside certain grounds for this purpose and the Government should in some appropriate way assist the municipalities so that they can give these fields. The future should find every city of 10,000 inhabitants with these landing fields.

"Secondly, we need wireless beacons or lighthouses, as it were, scattered over the country, and placed with just as much care as we exercise in the case of our lighthouses for our water navigation.

"There is no reason at all, from an engineering standpoint, why we cannot have dotted over this country, at landing fields, and at frequent intervals, little wireless signal towers that will give out a proper signal, and enable the aviator to fly across this country and run no danger of being lost.

"We also need various instruments of navigation. We have not a compass upon which we can entirely depend. The gyro compass, or something of that kind, must be developed. We also need drift instruments, so that the aviator may fly straight in one direction without being carried off to one side. These are some of the practical, simple things that have to be done to make aviation safe. Commercial aviation will follow, if we have landing fields, wireless lighthouses and the proper navigation instruments.

"In addition to landing fields, wireless lighthouses, and proper navigation instruments there are other less vital needs. There is the matter of meteorology. There has been given to us a third dimension—we must study the condition of air currents at the highest altitudes and make maps that can be used for aerial navigation, a work which the Weather Bureau might well be handling now. Exploration of higher altitudes made during the War showed that 95 per cent of all the winds at an altitude above 10,000 ft. are from the west and east, both in this country and Europe. Explorations were made at 35,000 ft. and some as high as 60,000 ft. One interesting record was made at Chattanooga, November 5, 1918, where at 28,000 ft. there was found an air current of 154 miles an hour, which means this: that an airplane going 154 miles an hour would be standing still going one way, or it would be going at the rate of 308 miles an hour the other way.

"Among other things, licensing of pilots is vital, so that we get competent men in charge of the aircraft. The testing of machines, to be sure that we have proper machines going into the service, flying rules, and other regulations are important.

"The Post Office Department has greatly helped commercial aviation and it ought to be encouraged. The kind of service it requires, flying in all kinds of weather, under all conditions, is tending to develop more reliable engines for the airplanes. It is also securing data on the cost of operation which will be available to the commercial enterprises that are to follow.

"The designs of machines for commercial aviation will have to be changed. We have in the last two years devoted our energies in the direction of high speeds, quick maneuvering ability, and similar matters, but we should get down to lower landing speeds, more comfort, and enclosed airplanes. Our controls will be worked differently, and a number of other things will have to be changed, but none of these are very serious matters."

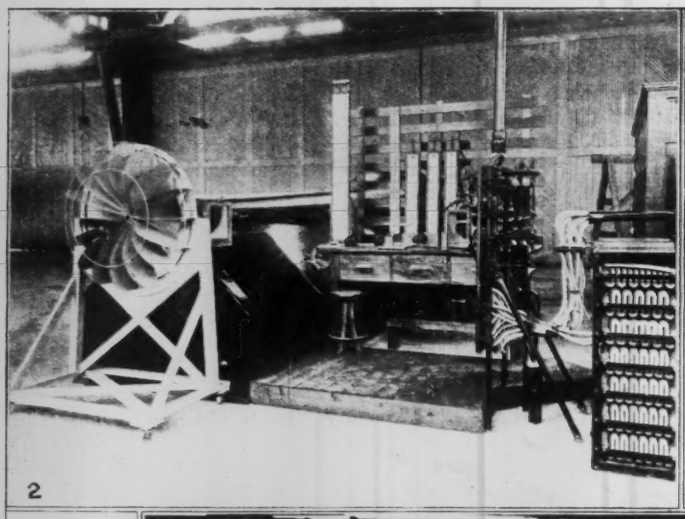
Colonel Deeds believes that the maximum size of the airplane, that is, the heavier-than-air craft for our commercial work, has been reached, unless we can get better landing facilities, and that the lighter-than-air type of aircraft will come into prominence for carrying the heavier loads.

The discovery and development of helium in this last War, which formerly was provided in the laboratory at the cost of $1700 per cu. ft., but now is available for less than 20 cents and is conserved by the Government, takes out of the lighter-than-air craft the one great hazard of fire, and with that hazard out of the way, an entirely new era is opening up. The lighter loads and greater speeds will be left to the smaller airplanes, perhaps, and heavier loads to the airships and to flying boats, which probably will be larger and more seaworthy.

In speaking of his own experiences and those of Mr. Kettering in flying, Colonel Deeds stated that the time required to go by plane from Dayton to Detroit is 2 hours; to Indianapolis, 1 hour; to Cleveland, less than 2 hours; to Washington, 3 hours; to New York, 4 hours; and to Wichita, Kansas, 7 hours. In addition to the great saving of time, the experience of flying is delightful. Colonel Deeds said that he believes in the privately owned airplane, but that he is restricted in his flying by the lack of landing fields and proper safeguards. Regarding casualties in flying, he said: "If you will take a list of the men who pioneered the automobile development, you will find that there is a long casualty list of men who have given their lives to that industry, and we have not any more of a casualty list in the airplane industry than in the automobile industry at this time."

Airplane development will come as that of the automobile came, first as a pleasure proposition and later as a utility proposition. Manufacturers are turning out a good many planes a week that are sold to individual fliers, but they have not the proper facilities for travel. Operating expenses are high but development of the industry will correct these. If engineers and manufacturers get together and are assisted by the Government, the airplane, while it probably will never attain the same degree of prominence that the automobile has attained, will nevertheless take a very important place in commerce. Aviation as an industry deserves the confidence and support of the conservative men of the country.

"Aviation will not reach the heights of the imagination which some have had about it," Colonel Deeds concluded, "but it will become a permanent part of the life of the people, and the thing that this country can do is to put the practical side into this industry for all civilization."



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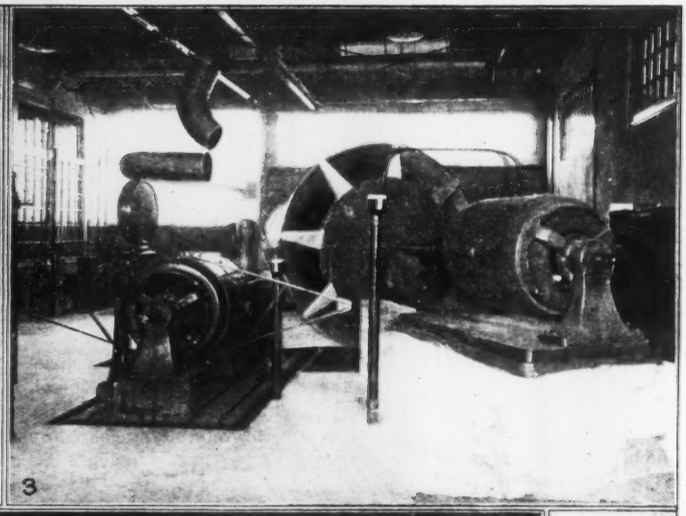

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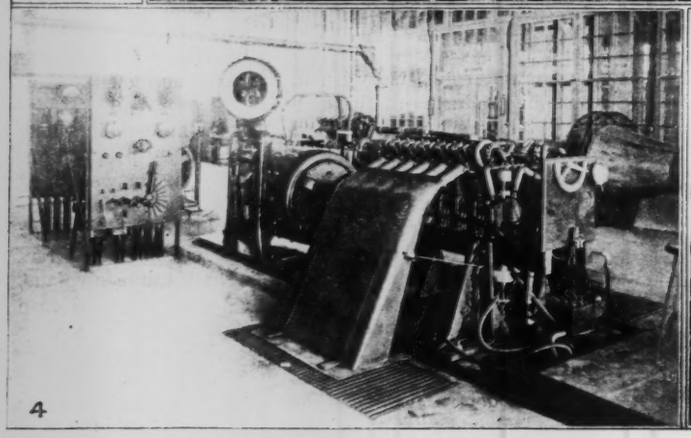

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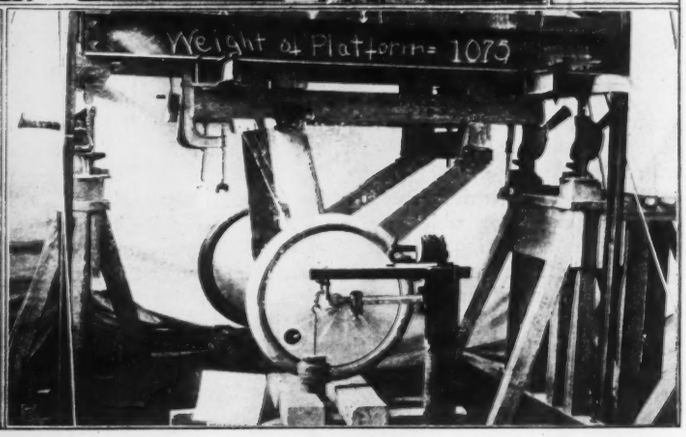
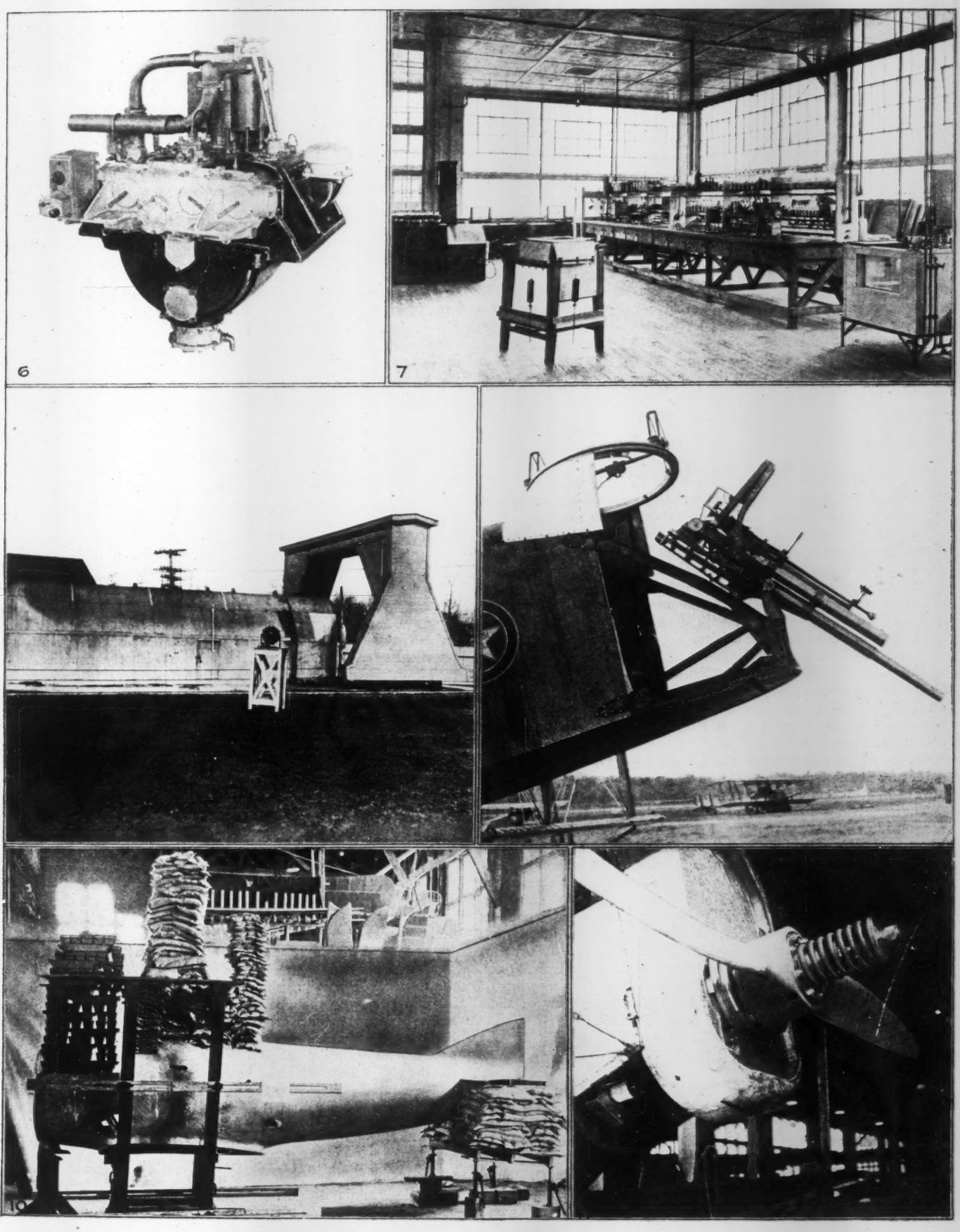


Views from McCook Field, Dayton, Ohio, Shown by Col. Thurman H. Bane, Chief of Engineering Division of Air Service, U. S. A., at Annual Meeting of the A.S.M.E.

Fig. 1—Airplane View of McCook Field, Showing Hangars, Headquarters, Supply Departments and Barracks; Fig. 2—High-Speed Wind Tunnel, Capable of a Velocity of 450 m.p.h.; Fig. 3—Dynamometer for Testing Air-Cooled Engines, With Wind-Tunnel Attachment in Order to Create a Similar Condition of Air Flow; Fig. 4—Engine Dynamometer, With Liberty-12 Motor on Test Stand Connected to Electric Dynamometer With Instrument Board; Fig. 5—Apparatus for Static Test of Landing Gears. Most Requirements Call for a Factor of Safety of 6.



These Views Were Selected from Those Used by Colonel Bane to Illustrate the Present Development of the Military Airplane, and the Equipment at McCook Field

Fig. 6—Dynamometer for Use in Connection with the Testing of Single Experimental Cylinders Shown Connected to Single-Cylinder Universal Engine; Fig. 7—Chemical Laboratory, Materials Section; Fig. 8—Propeller Whirling-Testing Stand Capable of Delivering 800 hp. in Measuring Deflections, Flutter, Etc.; Fig. 9—Thirty-seven mm. Automatic Cannon on Flexible Mount as Placed in the Martin Bomber; Fig. 10—Method of Static Test of Fuselage. Factor of Safety Required Varies with the Size of Airplane; Fig. 11—Propeller Thrustmeter Placed on a DH-4 with Liberty Engine, Which Mechanically Records the Thrust of the Propeller.

The Annual Meeting of the A. S. M. E.

Record Attendance of over 2100—Interest Centers on Committee Activities and Session on Industrial Unrest—Addresses on Aviation and Discussion of Valuation Problems Leading Features

ATTENDANCE at the Annual Meeting of The American Society of Mechanical Engineers found the Engineering Societies Building in holiday attire for the occasion, with the foyer on the first floor lavishly decorated with fir trees and palms and the other floors that were to be used appropriately arranged for the convenience of the Society's guests. Anticipating a large attendance, a Sub-Committee of the Committee on Meetings and Program, composed of local members having the social arrangements in charge, prepared to utilize all the available space in the building. Besides the Society's headquarters on the eleventh floor, the meeting rooms on the fifth and sixth floors and the auditorium were made use of, and on Thursday evening, the annual reunion night, members also gathered in the spacious foyer on the first floor. There are five public-meeting halls in the building, all of which were in use at times. The total attendance was 2116, of which 1346 were members and 770 guests, the largest at any meeting of the Society.

Although the convention nominally opened on Tuesday, December 2, many were present earlier for Council and committee meetings, Local Sections conferences, etc.; twenty-eight delegates were in attendance from the Local Sections of the Society.

There was widespread interest during the convention in the discussion upon the reports of the Aims and Organization Committee of the Society and the Joint Conference Committee of the Founder Societies, and in the conference of the Local Sections' delegates. A full account of these meetings will be found in Section Two of this number, with other matters of general interest pertaining to Society affairs.

Numerous committee meetings were also held, including those of the A. S. M. E. Power Test Codes and its Sub-Committee on General Instructions; Research Committee and its Sub-Committee on Fluid Meters; the Committee on Steel Roller Chains; the Committee on the Standardization of Shafting; and the Standardization Committee.

On the social side mention should be made in particular of the gathering at the ladies' reception and tea on Thursday afternoon, always one of the pleasantest occasions of the Annual Meeting.

The excursions to points of interest about the city were well attended, particularly that on Friday to the Curtiss aeroplane plant and flying field at Garden City where exhibition flights were given and special arrangements were made whereby members who so desired were able to undertake flights. As usual the meeting of representatives of student branches was held and following the convention on Friday evening there were numerous college reunions. An event of interest to many was an evening devoted to an account of the work of John Ericsson and Cornelius H. DeLamater, the founder of the famous DeLamater Iron Works, the occasion being the eightieth anniversary of the meeting of these two noted engineers and the thirtieth anniversary of their death. Several societies joined in these exercises.

The President's Address and Reception

The formal opening was on Tuesday evening, when President Cooley gave his presidential address on the Society's activities and national scope of the work of the engineer, printed elsewhere in this number. Following his address, the announcement of the election of officers for the ensuing year was made as follows: *President*, Fred J. Miller; *Vice-Presidents*, E. C. Jones, R. H. Fernald and J. R. Allen; *Managers*, D. S. Kimball, L. E. Strothman and E. F. Scott; *Treasurer*, William H. Wiley.

In introducing the President-elect, President Cooley said that he had had the kind of experience which in his opinion qualified a man to be the President of The American Society of Mechanical Engineers. For 20 years he was a journalist, since which time he had been engaged in the business of factory management, an expert on factory management. He served for five years on the Council of this Society, and for four years as Trustee of the United Engineering Society. His work as Trustee of the United Engineering Society had to do with the reorganization of its finances and other features, but principally the work of reorganization. During the past year he has had made a survey of the machinery—the office machinery—of the Society, and he has advised with regard to the development of MECHANICAL ENGINEERING, the Journal of the Society. He also rendered very distinguished service in the cause of his country during the war.

In replying, Mr. Miller said he regarded his election primarily an invitation to do more work, rather than a recognition of his service, and as such he gladly accepted it. His acquaintance with the history and methods of the Society made him fully appreciate that what should be done during the coming year would not depend so much upon the President as upon his fellow-members, and he would therefore bespeak the aid and coöperation of all those who desired to see the Society grow in numbers and in influence, keeping step with the best spirit and progress of the age.

The next event on the program was the conferring of Honorary Membership upon M. Charles de Freminville, consulting engineer, Creusot Works, France.

James Hartness, past-president Am. Soc. M. E., introduced M. de Freminville, who, he said, "is an engineer in the finest sense, a gentleman who understands the human element as well as the elements of machinery. He comes from a family, from an environment that combines the technical training with the practical life, that combines the science with the practice."

"M. de Freminville was one of the pioneers in introducing the corridor trains in France, and coming out of his long experience in engineering he has rendered distinguished service in the great war."

At the time when the long-range gun was shelling Paris, Mr. Hartness visited M. de Freminville in his home and went with him for a walk about the city to see some of the effects of the bombardment, and of the bombs which dropped from the aeroplanes. The spirit which M. de Freminville displayed at that time when his home and family were in such great danger made a deep impression on Mr. Hartness.

"While we are honoring one of the world's first engineers," he said, "we are also honoring a man who typifies that noble French spirit that took possession of the souls of the French people in that fight from the very first, and inspired their soldiers to 'carry on.'"

In his address of acceptance, M. Charles de Freminville expressed his deep appreciation of the tribute paid to him by the Society. Reviewing the history of the coöperation of America and France in their common ideal of civilization, he referred to the sewing machine as "the first object lesson which France had received from America," and the Westinghouse air brake as a second example. In return the Mallet compounding devices for the steam locomotive had been adopted in America and France had produced a steel car, the design of which inspired American engineers in the design of the present American steel car. The first low-level station was built in Paris, and it served as a model to the American engineers in the design of similar stations in New York. Again, coöperation between the two countries in automobile development had been very marked.

M. de Freminville also referred to the efforts made in both countries for the conquest of the air. In this connection he said:

While we were witnessing in France the successful experiments of Farman, about 1907, the news spread that two Americans, the Wright Brothers, had already obtained success in far greater achievements. This was very welcome, and this time France seemed to be the proper field for development of aviation. Count de Lambert flew over Paris some time later on a machine which he believed was designed by the

Wright Brothers, and he was promptly surpassed by Blériot crossing the Channel between Calais and Dover on his own machine.

M. de Freminville spoke of the work of Frederick W. Taylor and of the efforts of Professor Le Chatelier to introduce scientific management in France. The French public, he added, look upon the name of Taylor as a symbol of the efficient spirit that prevails in America.

He concluded by expressing the hope that America and France might come in closer contact by increasing interchange of students between the two countries. This interchange, he noted, has been highly beneficial in the past and would contribute greatly in the future to help the American and French engineers to develop a closer and more intimate friendship.

Following these exercises announcement was made that Honorary Membership was later to be conferred, in France, upon M. Auguste Camille Edmund Rateau, Chairman Board of Directors, Rateau, Battu and Smoot Company, France. Mr. F. R. Low was asked to outline the work of M. Rateau, which he did briefly, saying that he was a pioneer investigator in the field of the steam turbine and the turbo-compressor. He is author of basic tables and formulæ for the flow of steam through orifices, and author of methods of calculation and design of steam turbines now in practically universal use. He is the designer of numerous types of helicoidal fans. He is the inventor of the mixed-pressure steam turbine, and president of his own shops, manufacturing turbines and turbo-compressors as well as other types of high-speed rotating machinery, employing several thousand workmen. He has recently been active in the field of turbine propulsion of battleships, and in connection with the world war was author of notable contributions to the study of ballistics as well as inventor of devices to increase the efficiency of aeroplanes.

Business Meeting

President Mortimer E. Cooley called the business meeting together on Wednesday morning and asked Ira H. Woolson to present the proposed amendments to the constitution. These were as follows:

C45 The Standing Committees of Administration of the Society shall be

Committee on Finance
Committee on Meetings and Program
Committee on Publication and Papers
Committee on Membership
Committee on Local Sections
Committee on Professional Sections
Committee on Constitution and By-Laws

There shall be other Standing Committees of the Society as the By-Laws provide and the Council approves. The appointment, organization, duties and terms of service of all Standing Committees shall be as the By-Laws provide. The Chairman of all Standing Committees shall have a seat in the Council of the Society, but no vote. The Secretary of the Society shall be the Secretary of each of the Standing Committees.

C49 Professional Committees. The Council shall have power to appoint, upon a recommendation of the Society at a general meeting, or upon its own initiative, such Professonal Committees as it may deem desirable, to investigate, consider, and report upon subjects of engineering interest. Any proposed expenses of such committees must be authorized by the Council before they are incurred.

C50 The Society may approve or adopt any report, standard formula or recommended practice and may print the same in the Transactions. It shall, however, not approve any engineering or commercial enterprise. It shall not consent to the use of its name or initials in any commercial work or business, except to indicate conformity with its standards or recommended practices.

C46 (TO BE ELIMINATED. SUPERSEDED BY C50 ABOVE.)

C51 Each committee shall perform the duties required of it in the By-Laws, or assigned to it by the Council. Membership on the Council or any committee of the Society shall terminate automatically on account of absence of any member, either wilful, or due to force of circumstances, as provided in the By-Laws.

Mr. Woolson then moved that the meeting approve the proposed amendments in the form in which they had been offered and order them submitted to letter ballot. The motion was discussed by G. K. Parsons who asked if the action would preclude the operation of the Nominating Committee newly created. H. H. Vaughn wished to have the word "adopt" in C50 interpreted, and was asked to prepare such an interpretation with Robert I. Clegg, who offered his understanding of the meaning of the term. It was subsequently decided that the term would be interpreted in the by-laws.

L. P. Alford and Irving E. Moultrop also spoke on the motion, and R. H. Libbey sounded a note of warning against the ill-considered adoption of standards by the Society. R. H. Fernald called attention to a typographical error in C45.

The Secretary presented reports of Standing and Special Committees.

The preliminary Report of the Committee on Pipe Threads was presented by title by the Secretary and it was moved that the Society receive and order printed the report.

The Report of the Sub-Committee on Railway Locomotive Boiler Code was presented by H. H. Vaughn and members interested in the discussion of the Report adjourned to the Council room immediately.

Junior and Student prizes were awarded by the President to E. D. Whalen (junior) for his paper, "Properties of Airplane Fabrics," to C. F. Leh (junior) and F. G. Hampton (student) for their paper, "An Experimental Investigation of Steel Belting," to W. E. Helmick (student) for his paper on "An Experimental Investigation of Steel Belting." F. G. Hampton was present and received his prize in person. Upon a question by L. P. Breckenridge he informed the meeting that he and his collaborator were connected with Leland Stanford University, California.

Ira H. Woolson was called upon to introduce the chairman of the Sections Conference, A. C. Booth. In his remarks Mr. Woolson explained that the Society had taken action to create new machinery for the operation of the Nominating Committee in the nomination of officers of the Society. Legal advice had been obtained so that nominations had been made by the Sections delegates in conference, their action to be legalized by the adoption of a by-law to read as follows:

The nomination of the members of the Nominating Committee for the year 1920 made by the delegates of the Local Sections at their session held December 2, 1919, shall, if not revoked, be a sufficient nomination of this committee by the said delegates within the intendment of these by-laws.

The Committee on Constitution and By-Laws voted to accept this opinion, provided proper action was taken subsequently with regard to the details of the new machinery.

A. C. Booth, Chairman of the Sections Conference then reported the following list of members recommended for approval by the meeting to constitute a Nominating Committee:

Howard P. Fairfield	Worcester, Mass.
George K. Parsons	New York, N. Y.
G. A. Wechsler	Washington, D. C.
Elliot H. Whitlock	Cleveland, Ohio
George W. Galbraith	Cincinnati, O.
Chester B. Lord	St. Louis, Mo.
Robert Sibley	San Francisco, Cal.

Alternates were recommended as follows:

William W. Varney	Baltimore, Md.
H. G. Tyler	New York, N. Y.
Samuel W. Stratton	Washington, D. C.
C. M. Spaulding	Erie, Pa.
H. M. Norris,	Cincinnati, O.
J. A. Hunter	Boulder, Col.
E. O. Eastwood	Seattle, Wash.

It was voted that the recommendation be approved. Ira H. Woolson then moved that Council be recommended to adopt the temporary by-law necessary to legalize the action.

Memorial exercises in honor of Professor F. R. Hutton, including the presentation to the Society of a plaque, were held, Past-Presidents W. R. Warner and Ambrose Swasey, H. H. Suplee, Professor Hutton's sons, Mr. M. S. Hutton and Dr. Lefferts Hutton, being asked to take seats on the platform. The Secretary read the presentation address by William H. Wiley, acting Chairman of the Memorial Committee.

Past-President W. R. Warner spoke reminiscently of Professor Hutton and unveiled the plaque, which was accepted in the name of the Society by the President.

F. R. Low presented a memorial of William Kent, which was prepared by a committee of which he was chairman and distributed in pamphlet form at the meeting.

Major Fred J. Miller read a memorial to the members who had given their lives in the service and the following resolution was passed with a rising vote:

Resolved: That this Society hereby expresses its greatest appreciation of and pride in the services of its members who gave their lives that freedom might be preserved among the nations of the earth and that a copy of these resolutions be forwarded to the family of each of the members.

L. C. Marburg, Chairman of the Committee on Aims and Organization, presented the Report of the Committee to the Society. The discussion of the report was so lengthy that it was continued at an adjourned meeting in the afternoon and will be found in Section Two of this issue.

Morris L. Cooke presented an amendment to the Constitution, C6, which was received by the Secretary for presentation at the Spring Meeting as required by the Constitution.

Appraisal and Valuation Session

The Committee on Meetings and Program has received requests from time to time for papers and discussion upon the subject of Appraisal and Valuation of Property, a question in which many engineers are interested and about the principles of which there is a wide diversity of opinion. It was therefore decided to hold a session on this subject at the Annual Meeting, and a Committee, of which President Cooley was chairman, was appointed to arrange the details.

It subsequently developed that the American Society of Refrigerating Engineers, whose Annual Meeting occurs simultaneously with that of The American Society of Mechanical Engineers, were proposing to hold a similar session, and a joint session of the two Societies was accordingly planned for Wednesday, December 3. Papers contributed by the Refrigerating Engineers were upon Ice-Plant Depreciation, by George E. Wells, president of that society, and upon Depreciation of Insulation, by J. E. Starr. The A.S.M.E. contributed a paper on Appraisal and Valuation Methods, by David H. Ray, an abstract of which appeared in MECHANICAL ENGINEERING for December. Supplementing this was a series of contributions, carefully developed by the Committee in charge, for a progressive discussion of certain fundamentals upon which a plan for valuation methods might be based. These papers were as follows: Fundamental Principles of Rational Valuation, by James R. Bibbins; Development of Project, by the late F. B. H. Paine; The Construction Period, by H. C. Anderson; Price Levels and Value, by Cecil Elmes; and Original Costs and Normal Values, by R. H. Nexsen.

There was very evident interest in the session, as it was largely attended and the discussion lasted until a late hour. In fact, the attention which the subject received and the evident approval of those present led to a motion recommending that a committee corresponding to the Boiler Code Committee of the Society be appointed to go into the subject of appraisal and valuation, making a study of it for several years if need be, trying, if possible, to bring order out of chaos in respect to the methods to be followed. This motion was carried.

Inasmuch, however, as no opportunity was afforded for the proper digesting and discussing of the several papers presented at this session, it has been further proposed that certain or all of the papers be distributed in advance of the St. Louis meeting to be held next spring, and that discussion upon them be solicited for that meeting. It is probable that this will be done and that a digest of the discussion given at the Annual Meeting will also be sent out. In view of the situation, therefore, no attempt has been made at this time to report the discussion on appraisal and valuation at the Annual Meeting. Should the matter be assigned to the St. Louis meeting, as proposed, a suitable review of the whole matter will undoubtedly then be published.

Gas Power Session

The Gas Power Session was held on Wednesday afternoon, Dean Benjamin of Purdue University, presiding. The following papers were presented: The Hvid Engine and Its Relation to Fuel Problems, by E. B. Blakely; Combustion of Heavier Fuels in Constant-Volume Engines and in Engines of the Superinductive Type, by Leon Cammen; Kerosene as a Fuel for High Speed Engines, by L. F. Seaton; and Oil Pipe Lines, by S. A. Sulentic. The first two of these papers appeared in abstract form in the December number of MECHANICAL ENGINEERING on pages 918 and 941, respectively; the last two in the November issue on pages 881 and 883.

Mr. Blakely's paper drew forth considerable discussion in which the following points regarding the Hvid engine were brought out: The standard types are $1\frac{1}{2}$, 3, 6, and 8 hp., but larger units such as 15, 20, 30 and 60 hp. per cylinder are also being made. One marine concern is putting out a 25-hp. 4-cylinder block design with an electric starter; another is building 2, 4, and 6-cylinder units.

The cheapest grades of oil may be used for the Hvid engine as long as they are clean, free from grit, and will flow readily. The author told how crankcase oil obtained from a garage, after being strained through a piece of cheesecloth, was used by one concern to operate two of these engines. Undoubtedly this procedure saved several thousand dollars. Two fuel cups are supplied with each engine and about a half-hour is required to change over from a light-oil engine to a heavy-oil engine.

Carbonization in the cup may be attributed to the following causes: the cup being too hot when heavy oil is used; a cup designed for kerosene being used for heavy oil, or leakage occuring between the cup and the atmosphere. Other than these, the author knows of no other causes of carbonization.

Several of these engines have been running on test to see how long they will stand up and how long it will be before there will be trouble with the Hvid principle. Three 8-hp. engines have been running between five and six months. One of them has been in operation, both day and night, for a little over five months, with one shutdown, the cause of which is unknown, which occurred over two months ago. Since that time this engine has been running continually.

H. Schreck[1] took exception to the author's statement that the Diesel engine cannot be built for smaller units than 100 hp. He pointed out that a German firm has made a practice of building Diesel engines down to 8.5 hp. and has shipped them by hundreds to South America and Russia. In reply, the author stated that no small Diesel engines had been made in this country, and moreover that from the standpoint of initial cost, a small Diesel engine, with its complicated air compressors, could not compete with the simply constructed Hvid engine.

L. F. Seaton's paper on Kerosene as a Fuel for High-Speed Engines was read by title only.

In presenting his paper on the use of heavier fuels in constant-volume engines, Mr. Cammen pointed out that the gas turbine today is in the same state as aviation was before the advent of the Wright Brothers; moreover, the Wright Brothers of the gas turbine have not yet appeared. The United States, he said, is the greatest automobile-producing country in the world; nevertheless, during the past three years, more has been done abroad in the development of the new types of the internal-combustion engine, particularly as regards the superinduction types. Unless American engineers consider the effect of mass production and look to the future more carefully, we are apt to lose out in the automobile field just as, very unfortunately, we lost out in the development of the American invention, the aeroplane.

In the author's absence the paper by S. A. Sulentic was read by title only. In view of the fact that oil pipe lines have been so highly developed in this country, and further, that many available data exist in the hands of the builders and operators of these lines, Professor Lucke[2] expressed the opinion that such data should

[1] Consulting Engineer, New York City. Mem. Am. Soc. M. E.
[2] Prof. of Mechanical Engineering, Columbia University, N. Y. City. Mem.Am.Soc.M.E

be filed, either in the form of papers or discussions, and that they appear in the TRANSACTIONS of the Society. Professor Lucke also offered a resolution, which later was passed, that copies of Mr. Sulentic's paper be sent to engineers connected with pipeline and similar industries, with a request that they present written discussions verifying the conclusions arrived at, or substitute others for them, and that they add as many data as they can, in order that this valuable compilation become part of the TRANSACTIONS.

Session on the Industrial Situation in Relation to Present Conditions

At the session devoted to the Industrial Situation in Relation to Present Conditions, held on the morning of Thursday, December 4, four papers were presented, which, by reason of the vital importance of the subjects discussed, drew an audience that filled every seat of the main floor of the auditorium. These papers were: The Causes of Industrial Unrest and the Remedy, by Frederick P. Fish, Chairman, National Industrial Conference Board; Wage Payment, by A. L. De Leeuw, Consulting Engineer; Systems for Mutual Control of Industry, by William L. Leiserson, formerly Chief, Division of Labor Administration, Working Conditions Service, U. S. Department of Labor; and What May We Expect of Profit Sharing in Industry? by Ralph E. Heilman, Dean, School of Commerce, Northwestern University, Chicago. Owing to the absence of the author, Dr. Leiserson's paper was read by Secretary Rice. The discussion of these papers and of a set of resolutions offered by the New York Section required a continuation of the session throughout the afternoon. President Cooley opened the morning meeting, later calling Vice-President Spencer Miller to the chair. Prof. D. S. Kimball presided at the afternoon session.

Discussion of the papers was opened by the Hon. George M. Barnes, M.P., representing the British Joint International Labor Conference and who also represented Great Britain at the Peace Conference at Versailles. Mr. Barnes, in the course of his remarks, said that the labor problem in its essence was not only that a man should get higher wages and more to eat and better clothes, but that he should take his place on terms of equality with all other classes of the community. Workmen were no longer illiterate and could hold their own in discussions on economic subjects. Employers on both sides of the Atlantic were now recognizing this fact and also that workmen had the right to organize and bargain for the disposal of their labor through agents. He did not think that profit sharing would appeal to the workmen unless it was applied to organizations of labor over wide areas on a national basis instead of to isolated establishments. Paternalism was well enough when shops were small and when every employer could know his men, but was no longer feasible in the present era of large-scale production where an establishment sometimes employed twenty to thirty thousand men. The best way to abolish the industrial unrest, in his opinion, would be to recognize that the workmen had equal rights with capital to organize on a large scale, and he believed that frankly recognizing this fact would contribute to increased production and to the benefit of all concerned. Mr. Barnes' remarks were greeted with hearty applause.

A. L. Siff[1] submitted a written discussion in which he stated that strikes, lockouts and the like were as unnecessary today and as unjustifiable as any of the more serious breaches of civil and criminal law. We had built up a system of courts and legal procedure to adjudicate all civil and criminal disputes and we should adopt the same system to adjust labor questions. He outlined an elaborate plan for such adjustments which included a conference council in each company, as well as courts of appeals and various industrial zones for the country at large.

Harry Alexander[2] wrote describing a profit-sharing plan in which the men are rated in six classes, varying amounts being deducted from their normal share of profits. These deductions form an efficiency fund, 70 per cent. of which is divided between the two first-grade men, 20 per cent. among the three second-grade men and 10 per cent. among the five third-grade men. The men are rated 60 points for loyalty, 15 each for ability and judgment and 10 for speed. The plan, he said, had been in successful operation for many years.

Lewis H. Nash[3] believed that the present labor unrest was due to the fact that so many people had come here from foreign countries who consider work more as a degradation than an honor. He looked with great suspicion on any scheme that tended to limit the rights of an individual to run his business for the mutual benefit of himself and his employees without intermeddling by outside forces, either governmental, labor-union or other, because he believed individualism to be the basis of democracy.

A. C. Jackson[4] said that one question which should be considered was whether or not labor unions should be compelled to incorporate, so that an agreement made between a responsible corporation and a labor organization would be between two responsible parties and not as now between a responsible party and one irresponsible before the law; and further, that if such incorporation was made compulsory, the present exemption of labor organizations from the Sherman Anti-Trust Law should be removed.

William S. Bowen[5] said that the struggle between capital and labor now centered about the question of control in industry. At present it was controlled by property. Looking upon wages as the interest that labor received from its capital, he thought it was possible to devise forms of control certificates, issuable to both labor and investors, that would amalgamate the interests of both, and gave a brief outline of the provisions of these proposed certificates.

Frederic L. Meron[6], as his contribution to the discussion, presented particulars of a profit-sharing plan which he had recently published as part of a work on the Human Element in Organizations.

G. P. Hemstreet[7] said he had been urged many times to consider making partners of his workmen but felt that the union policy of limiting production hardly fitted a man to become a partner in a business. One thing that all could do was to see that their foremen became better acquainted with the men under them and treated them as human beings, for the foremen were the men who made or marred the reputation of a corporation with its employees.

Harrington Emerson[8], discussing Mr. De Leeuw's paper, said that what was most needed today was some authority or some arbiter who would determine for the employer and employee what was just; who could settle the unit of measurement for both sides so that it would not be guesswork. He knew of an experiment where 12,000 men were employed, in which such an arbiter had succeeded after a few years in increasing the amount paid out as wages over a million dollars annually. This man and his assistants drew up thousands of work schedules which had to be passed upon by officers of the company and accepted by the men before they became operative.

Walter N. Polakov[9] said that so long as goods continued to be produced primarily for profit instead of for use, we could not hope to attain a maximum production. What could and must be done in this connection was to settle on the definite amounts of goods necessary for consumption and then see to it that those amounts were produced with a maximum economy and a minimum loss. Today industry was absolutely uncoördinated and unregulated. If we had a competent council capable of determining how much

[1] Of the firm of Siff Bros. Co., Wholesale Clothiers, New York, N. Y.

[2] Pres. Harry Alexander, Inc., Contracting Engineer, New York, N. Y., Mem. Am. Soc. M. E.

[3] Pres. Nash Engineering Co., South Norwalk, Conn., Mem. Am. Soc. M. E.

[4] Gen. Supt. and Secy., Miller Lock Co., Frankford, Philadelphia, Pa., Mem. Am. Soc. M. E.

[5] 405 W. 118th St., New York, N. Y., Assoc. Mem. Am. Soc. M. E.

[6] Mechanical and Electrical Engineer, New York, N. Y.

[7] Gen. Works Mgr., Hastings Pavement Co., Hastings, N. Y., Mem. Am. Soc. M. E.

[8] Director, The Emerson Engineers, New York, N. Y., Mem. Am. Soc. M. E.

[9] Of Walter N. Polakov & Co., Consulting Engineers, New York, N. Y., Mem. Am. Soc. M. E.

and what goods were needed, as we had during the war, we might begin to see the light on other issues such as wage payment, organization of labor, etc., for these were capable of very simple solutions provided that those who were trying to settle them knew exactly what they were talking about and based their conclusions on facts, not on prejudices.

T. M. Ave-Lallemont,[1] in an extended discussion of Mr. Fish's paper, challenged the statement that "some form of representation in industry is essential in order to make personal relationship possible under modern industrial conditions." He argued that representation in industry was a means of social control and not at all a means to the "resumption of personal relationship between employer and employed." What the workers meant definitely was a share in the control of industry through representatives of their own choosing. Piece-work, premium and bonus systems of remuneration were objected to by workers because they had no control of the determination of the rates employed. There remained as a further step in development the "collective labor contract," under which the workers contributed to the compound labor required in the production of an article agree collectively to do their work at a certain contract price for the whole job. This form of contract involved the complete determinateness of the piece-work contract, the principles of collective bargaining and the possibilities of acceptance by the workers of the principles of scientific management. Only in this way, in his opinion, could be much-to-be-desired maximum of production and minimum of cost be obtained.

Resolutions Proposed by the New York Section on the Subject of Industrial Unrest

At the morning session, just prior to adjournment, L. P. Alford, representing the New York Section of the Society, took the floor and stated that the New York Section, during the preceding three months, had held a series of meetings to discuss aspects of industrial unrest. Acting in accordance with the wish expressed at one of these meetings, a brief declaration had been prepared on the subject, which was presented, discussed and approved at a largely attended meeting held on the evening of November 26, 1919, the motion of approval carrying a request that it be presented to the Council for their consideration and action. The Council had duly considered the declaration and referred it back to the Executive Committee of the New York Section, with a request that it be brought before the Society at the Annual Meeting. Mr. Alford then read the resolution together with two further resolutions which had been drawn up. At the afternoon session, following the discussion of the papers which had been presented in the morning, action was taken on these resolutions, and after a short debate they were adopted in the form given below.

Resolution No. 1—Declaration of Principles

Social and industrial unrest result from the fact that human relations have not kept step with economic evolution.

Competent directive management of essential enterprises is the logical solution. Such management must be free from autocratic control, whether by capital or by labor.

Sharp social or industrial disputes are no longer private. Society is affected, therefore such cases must be subject to the decision of authorities based upon intrinsic not arbitrary law.

Industry and public utilities must serve the people. There is no room for special privileges of capital or of labor. Strikes, irregular employment, or arbitrary acts of ownership or of management are harmful, not alone to the immediate parties but to society as a whole.

Productivity and public service are absolutely essential.

On account of the peculiarly intimate familiarity of engineers with industrial problems our responsibility is great.

Therefore, we, engineers and members of The American Society of Mechanical Engineers, declare that the following essentials are established by facts and experience, urge all of our members to uphold them, and invite other engineers to coöperate with us in having them unanimously recognized; viz:

> Every important enterprise must adopt competent productive management, unbiased by special privilege of capital or of labor, and disputes must be submitted to authorities based upon intrinsic law.
>
> Credit capital represents the productive ability of the community and should be administered with the sole view to the economy of productive power, that is, it should be granted only to those who are able to render valuable service.

Resolution No. 2

Moved, That a Committee on Agencies of Productivity be established with sub-groupings to study among others these major agencies:

1—Invested savings
2—Credit capital
3—Organized labor
4—Unorganized labor
5—Employers
6—Managers
7—Society as a whole
8—Economic and productive intelligence service.

Resolution No. 3

WHEREAS, The vital necessity of *immediate* constructive action in the field of industrial relations is beyond dispute; and

WHEREAS, Industrial "Society at Large" obviously stands in need of some organ or agency of continuous productive initiative; and

WHEREAS, A declaration of principles upon which to base constructive action has today been approved by the Society in Convention assembled; be it

Resolved, That we, members of The American Society of Mechanical Engineers, undertake to formulate a practical program for industrial relations betterment; and further,

That this Society undertake to formulate a practical plan of organization to assist in determining what immediate steps can be taken to put industrial relations on a better footing and coördinate and make effective the splendid work now being done by various agencies; and further,

That the Council of the Society be requested to appoint a committee of five members of The American Society of Mechanical Engineers to study and to make effective this program.

Machine Design Session

With the exception of one paper, the Machine Design Session, held in the Auditorium on Thursday, was devoted to a discussion of various types of rotating machinery. Dean Cooley presided and the following papers were presented in the order named: Reliability of Materials and Mechanism of Fractures, by Charles de Freminville, Hon. Mem. Am. Soc. M. E.; Tests on Dredging Pumps Used in Inner-Harbor Navigation Canal, New Orleans, by W. J. White; A Perfected High-Pressure Rotary Compressor, by C. B. Lord; Turbo-Compressor Calculations, by A. H. Blaisdell, and A New Type of Hydraulic-Turbine Runner, by Forrest Nagler. The papers by Messrs. Lord and Nagler will be found in abstract form in the November and December issues of MECHANICAL ENGINEERING; those by M. Charles de Freminville and A. H. Blaisdell will appear at some future date.

Mr. White's paper, which was presented by Prof. W. B. Gregory, was illustrated by numerous lantern slides and many of the views showing striking features of the work of constructing the New Orleans Industrial Canal are reproduced in connection with the abstract, which appears elsewhere in this issue.

It is of interest to recall in this connection that a similar problem was encountered during the construction of the Panama Canal and this fact was alluded to by H. Cadwallader, Jr.[1], in the discussion. Mr. Cadwallader told of the difficulties of that work and how changes in dredging equipment increased the amount of material removed from 110,000 yd. per month to 225,000 yd.

During the discussion which followed Mr. Lord's paper, which consisted chiefly of a series of questions put to the author, it was brought out that the high-pressure rotary compressor he described will not be manufactured on a commercial basis because the principle involved is applicable alike to vacuum pumps, fluid pumps and air pumps, and it is thus obviously impracticable to manufacture the compressor in all its various forms. An organization has accordingly been formed for the purpose only of licensing other concerns to manufacture the particular type of compressor they require. For example, if a certain company requires a compressor for Diesel engines this new organization will supply them with drawings, act in a consulting capacity and give them a license to manufacture in their own shops the particular type of compressor they require.

In response to an inquiry Mr. Lord stated that the compressor

[1] 161 West 36th St., New York, N. Y. Late member of Research Staff, National Industrial Conference Board.

[1] Efficiency Engineer, Philadelphia, Pa. Mem.Am.Soc.M.E.

had shown a mechanical efficiency of 86 per cent and a volumetric efficiency of 92.7 per cent, but as to its adaptability to various types of work, such as the pumping of Mexican fuel oils or the compressing of casing-head oil, Mr. Lord was unable to give any definite data.

Turbo-Compressor Calculations, by A. H. Blaisdell, was presented, but by title only. The paper contains a discussion of the features which differentiate the turbo-compressor from the multi-stage centrifugal pump.

The final paper of the session was presented by its author, Forrest Nagler, of Milwaukee, Wis. The type of runner described in the paper is a decided step forward in the development of the hydraulic turbine and it is of interest in this connection to quote from the remarks of Clemens Herschel, a hydraulic engineer who was intimately connected with the early development of the turbine.

"The Francis wheel, so-called, is a misnomer," said Mr. Herschel. "He never invented anything of the sort that is now called the 'Francis wheel.' Of course, I knew him personally, and used to work with him. The so-called 'Francis wheel' was invented by a man by the name of George F. Swain. Of course improvements were made and in those days most of the development was done by what were called cut-and-dry methods. They would make a model and try it. If it did not work they would plug it or shave it down a little, and finally get it to suit."

Discussion at Power Machinery Session

The discussion, of which a summary is here given, took place at the Power Machinery Session at the Annual Meeting and applies to the four papers which were read at the session: Emergency Fleet Corporation Water-Tube Boiler for Wood Ships, by F. W. Dean of the Emergency Fleet Corporation and Henry Kreisinger, engineer, U. S. Bureau of Mines; Flow of Water Through Condenser Tubes, by William L. De Baufre and Milton C. Stuart, of the U. S. Naval Experiment Station; Air Pumps for Condensing Equipment, by Frank R. Wheeler, of the C. H. Wheeler Mfg. Co., and The Thermal Conductivity of Insulating and Other Materials, by T. S. Taylor, non-member, of the Westinghouse Research Laboratory. Because of lack of room it has been impossible to give the discussion in complete form, but it is believed that what is presented here correctly records the most essential points that were brought out.

Emergency Fleet Corporation Water-Tube Boiler for Wood Ships

In opening the discussion, Joseph J. Nelis[1] emphasized the radical departure for the merchant marine, accustomed to the Scotch marine boiler, in the introduction of the water-tube boiler on merchant ships. The chief differences between this boiler and the standard in use in the United States Navy existed in closer tube spacing, larger grate area and the fact that there was no superheater. The boilers were designed with large grate areas to accommodate the use of Pacific Coast coals and natural draft, although all ships were equipped with fans. The tendency in the merchant marine, he said, was toward higher pressures, superheat and the use of turbines.

T. A. Marsh[2] wrote that the results of the experimental work by Mr. Kreisinger both as regards baffling and air supply over the fuel bed correspond with much that has been done in commercial practice by boiler and stoker companies during the past few years.

In the development of improved heat absorbers additional passes have been given to the gases in some of the standard boiler designs. Some of the first designs lacked proper areas, did not make due allowance for soot removal, and were difficult to maintain, but recent designs have made provision for overcoming these difficulties.

In changing a boiler from a 3-pass to a 4-pass baffling, one must always consider the additional draft loss due to high resistance to the gases and the reduction in draft due to lower exit temperatures. It is necessary if some desired rating is required from the boiler, to insure that the draft after changing the baffles will be sufficient to assure adequate fuel consumption, otherwise in the effort to improve efficiency the capacity will be reduced.

Referring to air admission over the grates, there is no question but that the author is correct regarding the inability to force sufficient air through the fuel bed. Auxiliary air supplies have been introduced through bridgewalls, side walls, through arches, at the front of the furnace and in fact at almost every section of the furnace. This has proven of advantage in many instances, particularly with furnaces of limited capacity for combustion of the gases.

Mr. Marsh had seen several instances of increased efficiency due to the introduction of auxiliary air and was thoroughly in accord with the idea of installing systems for admitting air above the fuel bed provided they are installed and operated under the supervision of competent combustion engineers. There are many more installations suffering from a large excess of air than from a deficiency, and it is with great caution that we should advocate admitting air other than under the fuel bed.

Larger furnaces or stoker firing may afford a better solution to the problem. Each furnace requires its own specific investigation.

In a written discussion, Albert A. Cary[1] drew attention to the circulation within the boiler. Three hundred and eighty-eight 3-in. tubes generating steam, he said, had for their outlet to the steam drum 21 three-inch tubes. This disparity of area was not thus wholly expressed, but the relative volumes of water and steam must also be considered. By applying the usual formula for calculating the flow of steam through pipes, it could be shown theoretically that the twenty-one 3-in. tubes delivering steam from the rear header to the cross-drum of this boiler were not only ample in number and size, but that the steam was flowing at an absurdly low velocity. But it would be found that the difference in pressure between the rear header and the front cross-drum actuating the flow of steam was very small. Steam merely flows in these tubes as rapidly as steam is being taken from the boiler, and the pressure in the steam drum never falls very much below the pressure in the rear header.

During the course of his professional experience, he said, he had been called upon to perform investigations which led him to experiments to determine the true velocity of circulation within a water-tube boiler. A light-running propeller wheel mounted in a thin disk of metal was placed in the tube in such a manner as not to interfere with the circulation of the water. The number of revolutions of the propeller was recorded by an electric chronograph placed outside the boiler and varied with the velocity of circulation. While the experiments were unsuccessful so far as determining the actual velocities was concerned, he was able to discover that the direction of circulation was not as he had supposed. The upward circulation from rear to front headers was very rapid in the several lower layers of tubes. Above the vertical center of the bank of tubes there was little or no velocity of flow; while near the top there was a reversed circulation, from the front, back to the rear headers. This showed that the outlets from the top of the headers to the steam drum could not deliver the steam from the tubes as rapidly as it was generated, resulting in reversed circulation. With the tubes thus largely filled with steam their value as heating surface became diminished.

He discovered subsequently that these observations had also been made by M. Brull, the French engineer, with boilers of the Babcock and Wilcox type. In England he had seen the efficiency of boilers greatly increased by the use of steam-extraction tubes which delivered the steam directly to the steam drum as soon as it was generated.

L. P. Breckenridge[2] congratulated the Society upon having pre-

[1] Asst. Engr., Emergency Fleet Corporation, 140 North Broad St., Philadelphia, Pa.

[2] Chief Engineer, Green Engineering Co., East Chicago, Ind. Mem.Am. Soc.M.E.

[1] 95 Liberty St., New York, N. Y.

[2] Professor of Mechanical Engineering, Sheffield Scientific School, Yale University, New Haven, Conn.

sented to it a paper by men so well qualified to do so as Messrs. Dean and Kreisinger, and pointed out that the complete combustion of fuel depended upon three things: the proper amount of air, mixed thoroughly with the fuel at the proper temperature.

R. Sanford Riley[1] thought that the water-tube boiler had made an effective entrance into merchant marine engineering practice, and that, due to the impossibility of obtaining skilled firemen at sea, the automatic stoker would soon come into use on ships.

John Van Brunt[2] said that underfeed stokers had been used on ships and that there was no mechanical reason why they should not come into universal use.

In the closure of the paper, Henry Kreisinger said that the Bureau of Mines experiments had showed that the circulation in boilers was as Mr. Cary had pointed out, very slight in the middle section of tubes and in opposite directions in the sets of tubes above and below. He did not imagine that the reversed circulation in the tubes would cause steam to remain in them for very long. He announced that the investigations published in the present paper would be completely reported in a publication of the Bureau of Mines.

Flow of Water Through Condenser Tubes

The discussion on this paper, opened by Joseph J. Nelis, centered around the packing of condenser tubes in marine condensers. William de Baufre said that the present marine practice with the Navy was the rolled joint with bent tubes to take up expansion and contraction strains. Edwin B. Ricketts[3] thought that the corset-lace packing of standard stationary condenser practice should prove equally as serviceable at sea as on land and John F. Grace[4] said that he had inspected condensers on a recent destroyer where the corset-lace packing had been used.

Philip E. Reynolds[5] and G. L. Kothny[6] asked about the friction losses at the entrance of the tubes, and R. J. S. Pigott[7] wanted to know if any condenser manufacturer had attempted to eliminate much of this entrance and exit friction by chamfering the ferrules. August H. Kruesi[8] said that he had always specified chamfered ferrules, and John F. Grace drew on the blackboard a diagram of the chamfered ferrule made by his company.

In closing, Professor de Baufre said that the experiments showed a loss of about 3 ft. of tube due to the entrance and exit friction, and that further experiments should be performed to see if it would be possible to reduce this to, say, 1 ft. He had no data on the effect of bent tubes.

Air Pumps for Condensing Equipment

By far the liveliest discussion of the Power Machinery Session was that on the paper by Frank R. Wheeler on Air Pumps for Condensing Equipment. After presenting the important features of his paper orally, Mr. Wheeler was followed by George J. Foran,[9] who read a lengthy discussion of the paper. Mr. Foran thought that the paper conveyed the impression that recent progress in the maintenance of high vacua was due to the introduction of the steam-ejector type of air pump, and gave evidence to show that such high vacua had been obtained by the rotative dry-vacuum pump in use for many years in commercial operation. He contended that every manufacturer of condensing equipment made ejector-type air pumps, and offered them for situations where he considered them advisable. His company had had no call for such pumps from the more important power plants.

He called attention of the members to a paper read before the National Edison Companies, in 1913, in which the hydraulic and rotative dry-vacuum pumps were compared. The power required by the hydraulic pump was several times that required by the rotative dry-vacuum pump, not 40 per cent as stated in the paper.

He submitted the performance curve of the Muller hydraulic pump (Fig. 1) with the statement that the pump had no small passages or sharp edges as stated by the author. He questioned accuracy of the figures given, and pointed out that the author had assumed an increased temperature corresponding to adiabatic compression which was true only for the steam ejector. The compression for dry air in the hydraulic vacuum pump was known to be isothermal. He then showed the effect of the actual conditions where the air was not dry, and that the hydraulic vacuum pump required less power than the ejector pump.

Mr. Foran criticized the author's statement regarding the mixture of air and water vapor, and said that the process should be

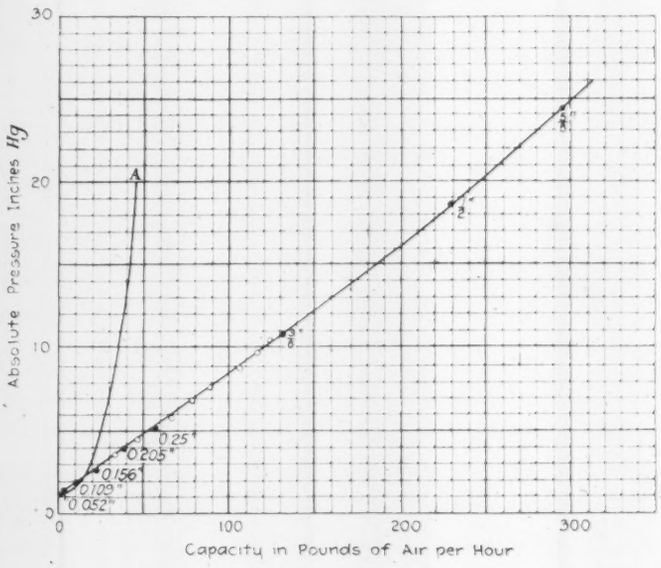


Fig. 1 Performance Curve of Muller Hydraulic Pump

clearly indicated by which the method of determining the relative volumes was deduced, and he thought that with Fig. 5 (Mechanical Engineering, December, p. 930) should have been shown also the curve showing volumes of 1 lb. of air at different pressures and temperatures of saturation. This curve, he contended, was applicable to the determination of volumes. He pointed out the discrepancy in figuring the volumes as had been done by the author.

With regard to Fig. 4, he pointed out that for the smaller capacities much less air allowance was shown than previously had been used, both in this country and abroad. On the other hand, the curve showed a much greater allowance than was required under actual conditions for the larger capacities.

Commenting on the statement that "the ratio of compression in the two stages (in the two-stage ejector pump) should be kept as nearly equal as possible," Mr. Foran pointed out that patents had been applied for such pumps under claims that:

a. Compression in first stage was greater than in second.
b. Compression in second stage was greater than in first.
c. Compressions in both stages were equal.

Philip E. Reynolds read a discussion in which he agreed with the conclusion of the author that the ejector type of air pump was the air pump par excellence. The fault of reciprocating pumps lay in the fact that the volumetric efficiency fell off very rapidly when high vacua were approached, that it was difficult to maintain high volumetric efficiency and to lubricate the pump.

He thought that the hydraulic air pump failed to meet the requirements in that it could handle only small quantities of air and was somewhat unstable at low vacua. The power required to obtain high vacua was very high. The openings were small

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[1] President, Sanford Riley Stoker Co., 25 Foster St., Worcester, Mass.

[2] Chief Engineer, Combustion Engineering Corporation, 11 Broadway, New York, N. Y.

[3] Asst. to Chief Operating Engineer, The New York Edison Company, 130 E. 15th St., New York, N. Y.

[4] Designing Engineer, Henry R. Worthington, Harrison, N. J.

[5] Vice-President, Croll-Reynolds Co., Inc., 95 Liberty St., New York

[6] Manager, Marine Department, C. H. Wheeler Mfg. Co., 18th St. and Lehigh Ave., Philadelphia, Pa.

[7] Supt., Raw Materials Department, Bridgeport Brass Co., Bridgeport, Conn.

[8] Engineer of Construction, General Electric Co., Schenectady, N. Y.

[9] Manager, Condenser Department, Worthington Pump and Machinery Corporation, 50 Church St., New York, N. Y.

and liable to become clogged; it required expensive equipment and the maintenance was high.

He said that the vacuum obtainable in a given condenser depended on the design and size of the condenser, the amount and temperature of the circulating water and the effectiveness of the air pump, and gave the basis for these statements. From an engineering standpoint, and with a given condensing equipment, the air pump which would remove the greatest volume of saturated air from the condenser would produce the best vacuum. However, there must be a compromise involving steam consumption, and the benefits derived from the increase in vacuum which might be obtained by increasing the volume of saturated air removed. It could readily be shown by simple mathematics, applying Dalton's law, that excessive volumes of saturated air might be removed from a condenser with only a negligible increase in vacuum. Just what volume it was best to specify to be removed depended on the design of the condenser, the temperature of the saturated air, steam consumption, benefits derived from increased vacuum, etc.

He said that the author's method of selecting the size of a pump was very simple, but was based upon the temperature of the saturated air leaving the condenser for determining which he gave no method excepting to state that it was assumed to be an average between the circulating inlet and outlet temperatures. This assumption could hardly be considered as accurate. It was not possible, he said, to obtain the temperature of saturated air by the usual mercurial thermometer and he had been led to regard the inconsistent readings obtained in attempting to determine this temperature as worthless as the basis of mathematical calculations.

He pointed out that the Croll-Reynolds ejector, shown in Fig. 10 of the complete paper, used two second-stage ejectors, each having different capacities. This gave the pump three capacities, a combination of the first with each of the second stages separately and the first with the two second stages combined for maximum capacity, thus obviating the use of two pumps.

The conclusion of the reading of the written discussions was a signal for advocates of the rotative dry-vacuum pump, the hydraulic vacuum pump and the ejector pump to vie with one another in debate, every speaker suffering the common fate of being misunderstood and of misinterpretating the meaning of his opponent's remarks.

Those taking part in the discussion were D. W. R. Morgan,[1] who contested that the openings of the hydraulic type of pump were not small, that the condenser manufacturer was interested in selling to the purchaser the type of pump best suited to his needs and that the capacity of the air ejector depended upon the vacuum; Paul A. Bancel[2], who argued that the methods of computing the size of the air pump from Fig. 5 and from Dalton's law would give different results; John F. Grace, who suggested that the temperature in the dry air pipe could be found by means of a bare thermometer passed through a cork, and that air leakage with a view to its reduction was the great question to be investigated by the engineer; William G. Starkweather,[3] who thought that the question of air pumps came down to one of simplicity and reliability, and whether due to design or other factors, there was a demand for ejector pumps; G. L. Kothny, who devoted himself to a refutation of Mr. Foran's and Mr. Morgan's criticisms; and John H. Lawrence,[4] who also pointed out that Fig. 4 was misleading.

An amplification of the remarks at this session will appear in TRANSACTIONS.

In his oral closure, Frank R. Wheeler answered as many of the criticisms as the circumstances would permit. He called Mr. Foran's attention to the paragraph in the paper in which he stated that the Muller hydraulic pump was a distinct type to which the remarks in a later paragraph did not apply. With reference to air leaks, he was under the impression that he had made it clear that this was a great defect. In different installations, conditions would vary, so that the curves given in the paper might or might not apply. In any case, they were the curves used in determining sizes of pumps furnished by his company, two pumps being furnished for each installation. In answer to an objection that had been raised to the ejector pump in that it would not perform properly under reduced steam pressure, Mr. Wheeler pointed out that the ejector pumps were furnished with pressure-reducing valves which supplied them with steam at 105 lb. pressure, the pressure for which they were designed to operate.

An abstract of the paper on Air Pumps for Condensing Equipment will be found in the December, 1919, issue of MECHANICAL ENGINEERING, the figure numbers in the foregoing discussion referring to that abstract.

Owing to the fact that T. S. Taylor, author of the paper entitled The Thermal Conductivity of Insulating and Other Materials, was unable to be present, the paper was presented by title only. There being no one to discuss the paper, the meeting was adjourned.

[1] Chief Engineer, Condenser Department, Westinghouse Elec. Mfg. Co., Machine Works, East Pittsburgh, Pa.

[2] Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

[3] Starkweather and Broadhurst, 53 State St., Boston, Mass.

[4] Asst. M. E., The New York Edison Co., Irving Place and 15th St., New York, N. Y.

Textile Session

At the Textile Session, called to order by C. T. Plunkett, chairman of the sub-committee on Textiles, on Thursday afternoon, the following papers were presented: Teaching and Training Mill Employees, by Roy DeMitt; Steam Use in Textile Processes, by Geo. H. Perkins; Electric Power Supply to Southern Mills, by J. E. Serine; and Possibilities of Mechanical Handling of Materials in Textile Mills, by Kenneth Moeller. All of these papers with the exception of that by Mr. Perkins will later appear, in abstract form, in MECHANICAL ENGINEERING. Mr. Perkins' paper will be found on page 14 of this issue.

Mr. De Mitt[1] in presenting his paper on Teaching and Training Mill Employees, told of the methods employed in the southern states to educate mill operatives. Many of these mills run ten hours a day, and under the Federal Child Labor Act it is not permissible to work those under sixteen years of age over eight hours a day. After careful investigation it was decided to split the day into two five-hour shifts, and to compel the child operative to attend school for the remainder of the eight hours. This system, together with compulsory school attendance, has been extensively adopted throughout the South.

Four types of vocational school are employed: The vestibule school, in which would-be operatives are trained for their particular work when entering a mill; the all-day school, which the operative attends on alternate days; the part-time school, which the operative attends during part of each working day; and the evening school, which is attended outside of working hours. Short courses are offered because it is impossible to get the operative to sign up for a great length of time, and it has also been found advisable to teach subjects which will be of immediate use to the student rather than those of a more theoretical nature which might be of some practical use in the future.

The Smith-Hughes Act, providing for industrial education as well as other types, carries with it an appropriation of $7,000,000 per year. In the South the agricultural people get the bulk of this, although the state boards are usually in a position to render considerable financial assistance.

George H. Perkins presented his paper with the aid of lantern slides, and showed the useful results of a great deal of laborious research. Chas. T. Main[2] recalled the great dearth of information on the subject and emphasized the fact that it is very desirable to have such data for future reference.

Because of the absence of the author, J. E. Serine's paper was read by title only.

Kenneth Moeller's paper, illustrated by means of lantern slides, discussed different methods of transporting material from one part of a mill to another by means of conveyors. Among the

[1] Federal Board of Vocational Education, Atlanta, Ga.

[2] Consulting Engineer, Boston, Mass. Past-Pres. Am. Soc. M. E.

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He submitted the performance curve of the Muller hydraulic pump (Fig. 1) with the statement that the pump had no small passages or sharp edges as stated by the author. He questioned accuracy of the figures given, and pointed out that the author had assumed an increased temperature corresponding to adiabatic compression which was true only for the steam ejector. The compression for dry air in the hydraulic vacuum pump was known to be isothermal. He then showed the effect of the actual conditions where the air was not dry, and that the hydraulic vacuum pump required less power than the ejector pump.

Mr. Foran criticized the author's statement regarding the mixture of air and water vapor, and said that the process should be

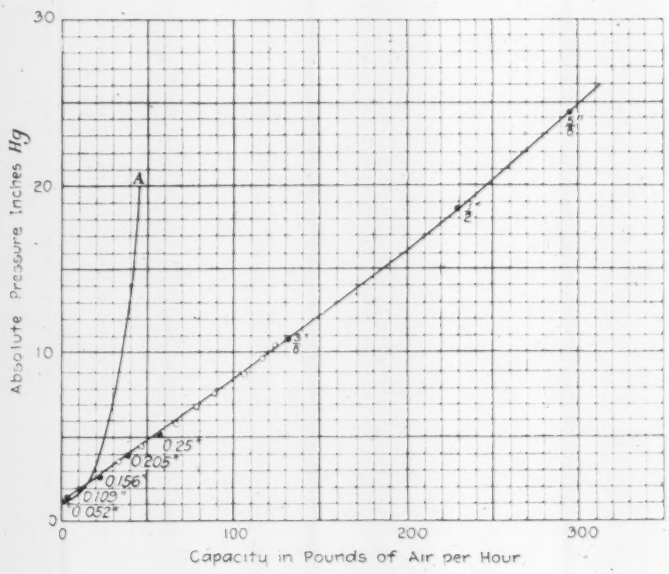

Fig. 1 Performance Curve of Muller Hydraulic Pump

clearly indicated by which the method of determining the relative volumes was deduced, and he thought that with Fig. 5 (Mechanical Engineering, December, p. 930) should have been shown also the curve showing volumes of 1 lb. of air at different pressures and temperatures of saturation. This curve, he contended, was applicable to the determination of volumes. He pointed out the discrepancy in figuring the volumes as had been done by the author.

With regard to Fig. 4, he pointed out that for the smaller capacities much less air allowance was shown than previously had been used, both in this country and abroad. On the other hand, the curve showed a much greater allowance than was required under actual conditions for the larger capacities.

Commenting on the statement that "the ratio of compression in the two stages (in the two-stage ejector pump) should be kept as nearly equal as possible," Mr. Foran pointed out that patents had been applied for such pumps under claims that:

a. Compression in first stage was greater than in second.

b. Compression in second stage was greater than in first.

c. Compressions in both stages were equal.

Philip E. Reynolds read a discussion in which he agreed with the conclusion of the author that the ejector type of air pump was the air pump par excellence. The fault of reciprocating pumps lay in the fact that the volumetric efficiency fell off very rapidly when high vacua were approached, that it was difficult to maintain high volumetric efficiency and to lubricate the pump.

He thought that the hydraulic air pump failed to meet the requirements in that it could handle only small quantities of air and was somewhat unstable at low vacua. The power required to obtain high vacua was very high. The openings were small

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[1] President, Sanford Riley Stoker Co., 25 Foster St., Worcester, Mass.

[2] Chief Engineer, Combustion Engineering Corporation, 11 Broadway, New York, N. Y.

[3] Asst. to Chief Operating Engineer, The New York Edison Company, 130 E. 15th St., New York, N. Y.

[4] Designing Engineer, Henry R. Worthington, Harrison, N. J.

[5] Vice-President, Croll-Reynolds Co., Inc., 95 Liberty St., New York

[6] Manager, Marine Department, C. H. Wheeler Mfg. Co., 18th St. and Lehigh Ave., Philadelphia, Pa.

[7] Supt., Raw Materials Department, Bridgeport Brass Co., Bridgeport, Conn.

[8] Engineer of Construction, General Electric Co., Schenectady, N. Y.

[9] Manager, Condenser Department, Worthington Pump and Machinery Corporation, 50 Church St., New York, N. Y.

and liable to become clogged; it required expensive equipment and the maintenance was high.

He said that the vacuum obtainable in a given condenser depended on the design and size of the condenser, the amount and temperature of the circulating water and the effectiveness of the air pump, and gave the basis for these statements. From an engineering standpoint, and with a given condensing equipment, the air pump which would remove the greatest volume of saturated air from the condenser would produce the best vacuum. However, there must be a compromise involving steam consumption, and the benefits derived from the increase in vacuum which might be obtained by increasing the volume of saturated air removed. It could readily be shown by simple mathematics, applying Dalton's law, that excessive volumes of saturated air might be removed from a condenser with only a negligible increase in vacuum. Just what volume it was best to specify to be removed depended on the design of the condenser, the temperature of the saturated air, steam consumption, benefits derived from increased vacuum, etc.

He said that the author's method of selecting the size of a pump was very simple, but was based upon the temperature of the saturated air leaving the condenser for determining which he gave no method excepting to state that it was assumed to be an average between the circulating inlet and outlet temperatures. This assumption could hardly be considered as accurate. It was not possible, he said, to obtain the temperature of saturated air by the usual mercurial thermometer and he had been led to regard the inconsistent readings obtained in attempting to determine this temperature as worthless as the basis of mathematical calculations.

He pointed out that the Croll-Reynolds evactor, shown in Fig. 10 of the complete paper, used two second-stage ejectors, each having different capacities. This gave the pump three capacities, a combination of the first with each of the second stages separately and the first with the two second stages combined for maximum capacity, thus obviating the use of two pumps.

The conclusion of the reading of the written discussions was a signal for advocates of the rotative dry-vacuum pump, the hydraulic vacuum pump and the ejector pump to vie with one another in debate, every speaker suffering the common fate of being misunderstood and of misinterpretating the meaning of his opponent's remarks.

Those taking part in the discussion were D. W. R. Morgan,[1] who contested that the openings of the hydraulic type of pump were not small, that the condenser manufacturer was interested in selling to the purchaser the type of pump best suited to his needs and that the capacity of the air ejector depended upon the vacuum; Paul A. Bancel[2], who argued that the methods of computing the size of the air pump from Fig. 5 and from Dalton's law would give different results; John F. Grace, who suggested that the temperature in the dry air pipe could be found by means of a bare thermometer passed through a cork, and that air leakage with a view to its reduction was the great question to be investigated by the engineer; William G. Starkweather,[3] who thought that the question of air pumps came down to one of simplicity and reliability, and whether due to design or other factors, there was a demand for ejector pumps; G. L. Kothny, who devoted himself to a refutation of Mr. Foran's and Mr. Morgan's criticisms; and John H. Lawrence,[4] who also pointed out that Fig. 4 was misleading.

An amplification of the remarks at this session will appear in TRANSACTIONS.

In his oral closure, Frank R. Wheeler answered as many of the criticisms as the circumstances would permit. He called Mr. Foran's attention to the paragraph in the paper in which he stated that the Muller hydraulic pump was a distinct type to which the remarks in a later paragraph did not apply. With reference to air leaks, he was under the impression that he had made it clear that this was a great defect. In different installations, conditions would vary, so that the curves given in the paper might or might not apply. In any case, they were the curves used in determining sizes of pumps furnished by his company, two pumps being furnished for each installation. In answer to an objection that had been raised to the ejector pump in that it would not perform properly under reduced steam pressure, Mr. Wheeler pointed out that the ejector pumps were furnished with pressure-reducing valves which supplied them with steam at 105 lb. pressure, the pressure for which they were designed to operate.

An abstract of the paper on Air Pumps for Condensing Equipment will be found in the December, 1919, issue of MECHANICAL ENGINEERING, the figure numbers in the foregoing discussion referring to that abstract.

Owing to the fact that T. S. Taylor, author of the paper entitled The Thermal Conductivity of Insulating and Other Materials, was unable to be present, the paper was presented by title only. There being no one to discuss the paper, the meeting was adjourned.

Textile Session

At the Textile Session, called to order by C. T. Plunkett, chairman of the sub-committee on Textiles, on Thursday afternoon, the following papers were presented: Teaching and Training Mill Employees, by Roy DeMitt; Steam Use in Textile Processes, by Geo. H. Perkins; Electric Power Supply to Southern Mills, by J. E. Serine; and Possibilities of Mechanical Handling of Materials in Textile Mills, by Kenneth Moeller. All of these papers with the exception of that by Mr. Perkins will later appear, in abstract form, in MECHANICAL ENGINEERING. Mr. Perkins' paper will be found on page 14 of this issue.

Mr. De Mitt[1] in presenting his paper on Teaching and Training Mill Employees, told of the methods employed in the southern states to educate mill operatives. Many of these mills run ten hours a day, and under the Federal Child Labor Act it is not permissible to work those under sixteen years of age over eight hours a day. After careful investigation it was decided to split the day into two five-hour shifts, and to compel the child operative to attend school for the remainder of the eight hours. This system, together with compulsory school attendance, has been extensively adopted throughout the South.

Four types of vocational school are employed: The vestibule school, in which would-be operatives are trained for their particular work when entering a mill; the all-day school, which the operative attends on alternate days; the part-time school, which the operative attends during part of each working day; and the evening school, which is attended outside of working hours. Short courses are offered because it is impossible to get the operative to sign up for a great length of time, and it has also been found advisable to teach subjects which will be of immediate use to the student rather than those of a more theoretical nature which might be of some practical use in the future.

The Smith-Hughes Act, providing for industrial education as well as other types, carries with it an appropriation of $7,000,000 per year. In the South the agricultural people get the bulk of this, although the state boards are usually in a position to render considerable financial assistance.

George H. Perkins presented his paper with the aid of lantern slides, and showed the useful results of a great deal of laborious research. Chas. T. Main[2] recalled the great dearth of information on the subject and emphasized the fact that it is very desirable to have such data for future reference.

Because of the absence of the author, J. E. Serine's paper was read by title only.

Kenneth Moeller's paper, illustrated by means of lantern slides, discussed different methods of transporting material from one part of a mill to another by means of conveyors. Among the

[1] Chief Engineer, Condenser Department, Westinghouse Elec. Mfg. Co., Machine Works, East Pittsburgh, Pa.

[2] Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

[3] Starkweather and Broadhurst, 53 State St., Boston, Mass.

[4] Asst. M. E., The New York Edison Co., Irving Place and 15th St., New York, N. Y.

[1] Federal Board of Vocational Education, Atlanta, Ga.

[2] Consulting Engineer, Boston, Mass. Past-Pres. Am. Soc. M. E.

advantages of such systems are: that the trucking is done "on the ceiling" instead of on the floor, and that the mill requires about 20 per cent less operatives.

Transportation Session

At this session, held on the morning of Friday, December 5, in the Auditorium, Prof. W. B. Gregory presiding, two papers were presented, namely: Scientific Development of the Steam Locomotive, by John T. Muhlfeld, and Motor-Transport Vehicles for the United States Army, by John Younger. Abstracts of these papers appeared in the November issue of MECHANICAL ENGINEERING.

SCIENTIFIC DEVELOPMENT OF THE STEAM LOCOMOTIVE

Discussing this paper, F. J. Cole[1] wrote that much remained to be done in the way of designing boilers to safely and economically operate under pressure of 350 lb. and over. Hard riding, he said, did not always arise from improper counterbalancing, but might be due to worn driving-box bearings, etc. When more than four driving axles were used, flange wear should be taken into account and lateral-motion driving boxes or conjugated leading trucks employed. Attention should be given to details of domes and throttle valves so that water is not carried out into the steam pipes. The increasing cost of fuel seemed to warrant the use of many devices not considered economically desirable a few years ago.

Clement F. Street[2], discussing rule-of-thumb methods in design, said that scientific methods were all right in their place, but when it came to locomotive boilers, the thing to do was, as the late M. N. Forney had said, to "make the boiler just as big as you can." As to stoker-fired engines burning more coal than those hand-fired, that was the very purpose for installing the stoker—it was not intended as a fuel saver.

George L. Fowler[3] said that in regard to the disadvantage of using trucks, experience had shown that a symmetrical-wheelbase engine such as the Mikado type was much harder on the rails than a Consolidation engine, which has an unsymmetrical wheelbase and no trailing wheels on the back. He was unable to see what was to be gained in the way of evaporation by rapid circulation in a locomotive boiler, but it was an excellent thing as far as internal stresses due to expansion were concerned.

H. B. Oatley[4] wrote expressing his belief that a locomotive-boiler pressure of 500 lb. would be safely and economically used in the near future. Further, that the present method of transmitting power would be superseded by an improved type of construction that would result in the elimination of considerable unbalanced reciprocating and rotating weight and consequently in less rapid deterioration of rail, rail bed and driving mechanisms. Condensing operation would also be adopted.

Otto S. Beyer, Jr.,[5] said that in any discussion of the economy of electrified roads the possibilities of the super-power plant, located in the coal district itself and doing away with fuel haulage, should be considered. With rising labor costs it seemed to him that a premium would be placed more and more on speed in railway operation, which in turn would mean faster locomotives. The time element would also have to be taken into consideration in the matter of train loading. It was not a question of what a locomotive could haul up the maximum grade at the slowest possible speed.

Edwin B. Katte[6], referring to the author's remarks on the electric locomotive, said that the fact that nearly every large railroad in the country is now operating a part of its system electrically would indicate that the capital cost is not prohibitive. As to interchangeability, steam locomotives did not habitually leave the divisions to which they were assigned, nor would electric locomotives. There was hardly an electrification nowadays but what had the advantage of two or three or possibly six or eight power stations feeding into its own transmission system by various routes. In regard to congestion of road, it was quite generally accepted that a yard or terminal or line would have its capacity increased 25 per cent or more by electrification. As to operating costs, it was not difficult to arrive at the cost of electric operation; the difficulty was to obtain the comparable cost of superseded steam operation. As to tie-ups, it had been the experience of most steam roads that during snow storms and blizzards the electrified divisions operated more nearly 100 per cent than the steam divisions.

George Gibbs[1] whote that electric traction was too big a subject to be disposed of in a few paragraphs. The author was mistaken in his belief that expected results had not been quite generally attained. More money had been made for the stockholders by reducing operating expenses, or by producing new business either by more attractive or more reliable service, or by an increase of capacity of the railways' facilities. He thought it entirely creditable to engineers that they had been able in the short period of, say, ten years' time, to develop electric locomotives which are reliable in service, have a moderate upkeep cost and which exceed in hauling capacity the most powerful steam locomotives.

Mr. Muhlfeld, in closing, said that in the boiler being designed for higher pressures the largest diameter of the shell, which was made of 1¼-in. plates, was 68 in. This was about as large a boiler as could be handled at present by locomotive builders. Mr. Oatley had referred to 500 lb. pressure. What had limited him in his argument in the paper to 350 lb. was the cylinder temperature, not boiler troubles; and tests made during the past three years had shown that a higher temperature than 750 deg. fahr. would be one that would destroy the cylinders, packing and bushings.

In the matter of burning coal, to which Mr. Street had referred, he would say that during the past five years he had made numerous tests of the cinders taken from the back of a stoker-fired locomotive and from accumulations in small boxes placed on top of a freight train, and had found that in nearly every case they were unconsumed particles of fuel. The coal was being put through the boiler but was not being burned.

In regard to questions propounded by Messrs. James H. S. Bates and Wm. H. Wood, he would say in reply to the former that the steam turbine had not as yet been adapted to the locomotive, and to the latter that fireboxes with flexible stays were being eliminated.

MOTOR-TRANSPORT VEHICLES FOR THE UNITED STATES ARMY

The discussion of this paper was opened by Arthur J. Slade,[2] who said that the most intelligent opinion of the A. E. F. would undoubtedly disagree with the author's statement regarding operation of trucks off the roads. Any vehicle running on wheels required a supporting foundation, even caterpillar tractors, and in France before vehicles could keep pace with advancing troops it was always necessary to repair the worst spots in the roads. The matter of personnel was vital as with the most highly refined types of equipment, military motor transport in the mass could not function properly without systematic organization. He believed that the solution of the intricate questions involved could best be found by a commission of really qualified experts who had been associated with the M. T. C. activities in the A. E. F. and who in coöperation with a board of army officers with similar experience could work out a sound constructive program that would justify the support of both the regular army and the general public.

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[1] Chief Consulting Engineer, American Locomotive Co., Schenectady, N. Y. Mem.Am.Soc.M.E.

[2] Consulting Engineer, New York. Mem.Am.Soc.M.E.

[3] Consulting M. E., New York. Mem.Am.Soc.M.E.

[4] Chief Engineer, Locomotive Superheater Co., New York. Mem.Am.Soc.M.E.

[5] Captain, U. S. A., Washington, D. C. Jun.Mem.Am.Soc.M.E.

[6] Chief Engineer, Electric Traction, U. S. R. R. Administration, New York. Mem.Am.Soc.M.E.

[1] Consulting Engineer, Gibbs & Hill, New York. Mem.Am.Soc.M.E.

[2] Lieutenant-Colonel, Aviation Section, Unattached, A. E. F. Mem.Am.Soc.M.E.

F. H. Pope[1] said that doubtless more rugged truck construction was necessary in military than in commercial vehicles, but army experience was apt to be misleading on this point as they had found the great cause for vehicle breakdown to be poor operation. As to the advisability of the 3-ton type, he would say that this type was urgently recommended for our army in 1916 by officers who had had actual motor-transport experience. The 1½-ton truck had its special value over a heavier truck in being more rapid, entailing less loss of capacity in bulky loads and being the truck par excellence for personnel carrying, but it was open to the objection made by Mr. Younger. Special vehicles, he believed, should not be allowed where standard types would answer the purpose. Motor cars and trucks should be districted by make or model, either in divisions or territorial districts. The 4-wheel-drive type had a very positive value, chiefly for artillery work, where their tractor properties could be utilized, and for cargo work over mountainous or difficult terrain. The caterpillar type, however, was the only one that was really serviceable in very difficult territory.

B. F. Miller[2] said that in the future the country would undoubtedly have a military policy, upon which would be based programs for any emergency that might arise, and he believed that motor-vehicle designers and engineers, manufacturers and military authorities should all have a part in perfecting such programs. The peace-time equipment of the army would probably be limited to that actually required for peace-time necessities but this equipment should be kept up to date by the yearly purchase and replacement of 20 per cent. of new equipment. He was of the opinion that we should not cling to the fetish of exclusive military design unless it could be shown to be capable of being produced more rapidly and economically than selected types of commercial design adapted to military requirements. Ford cars would be used in the future near the front lines and where the roads were bad, and light trucks would also be used to replace the animal-drawn vehicles of combat troops for cargo carrying. Four-wheel-drive trucks would always be required, not only for use with artillery and other hauling off the roads but also for cargo hauling. The use of trailers, in his judgment, should be limited to hauls that were obviously suitable and for mounting certain special equipment and bodies that were required to be moved infrequently.

William P. Kennedy[3] said he believed that standards must be effected by means of some compromise between military engineers and commercial engineers representing the most prominent manufacturers, who would discuss and lay down the principles that would be incorporated in the machines that were necessary to serve the army purposes. That is, the military organization could not expect to get all it would design or demand for its own interests and would have to accept a compromise between that and what the manufacturers considered it desirable to produce to remain in business and in such condition that they could produce quantities of trucks in a short time without great loss.

Alfred F. Masury[4] said that undoubtedly specially designed vehicles to meet the requirements of the army would be superior to any commercial vehicles, if for no other reason than on account of standard parts. The War Department, however, could not be expected to carry on hand in peace times a large stock of up-to-date war vehicles. It would therefore seem best to employ commercial vehicles so far as possible in the army and restrict the specially designed vehicles to those special uses for which truck and other special equipment was used. Commercial designers should be encouraged to incorporate in their designs features which might be of military use and which would also be of commercial use, such as provision for high gear ratios, etc.

G. R. Young,[5] in an extended written discussion, said among other things that one reason for standardization that should be strongly emphasized was the importance of reducing as much as possible the varieties of makes and types of vehicles for the army. Motor vehicles for army use should be capable of taking great overloads, withstanding rough handling and operating under bad road conditions. To make any program a success it would be necessary in peace times to have the army supplied with, say, 40,000 to 50,000 motor vehicles. Immediately on the outbreak of a war, 20,000 or more must be immediately obtainable. In four to six months, under the gruelling conditions of field service, the motor vehicles first sent out would begin to wear out and break down in large numbers and would have to be replaced. This would call for, say, 50,000 vehicles, with further large increments until the close of the war. The peace-time estimate under a five-year replacement scheme would call for 8000 new vehicles a year. The question was, would manufacturers be sufficiently interested in a share of this business to construct these standardized vehicles with tools and fixtures for which the Government assumed the expense of keeping up to date?

Mr. Younger, in his closure, said that those in charge at Washington had to face facts as they were and their policies had been developed from day to day instead of during the period preceding the war. The paper had touched on important points that should be considered in the policy that should govern us during the next few years. There must be no compromise decisions in the future. The question of personnel raised by Colonel Slade was one of exceedingly great importance. The automobile industry had been successively called upon to furnish personnel to care for the tremendous expansion in aircraft, fighting-tank, agricultural-tractor and submarine-chaser activities. The truck industry had to take what was left, which was one reason why many things appeared terrible overseas. While it was perfectly true that it had been found necessary to introduce new types of vehicles, if the war had lasted three years longer, which was expected at the last, he believed they would have been justified in their adoption.

As Mr. Kennedy had said, it was highly probable that a compromise would have to be effected, and one strong compromise suggested during the war was that vehicles of different makes be zoned. With a static battlefield as in France it would be easy to arrange these zones, but with a mobile battlefield as we had in Mexico other elements had to be considered. As to commercial-vehicle manufacturers supplying the vehicles in the future, if the army could dictate what kinds of guns and harness it was going to use, why should it not have the right to dictate, if it so desired, what type of motor vehicle it should use? One interesting thing in this connection was the question of roads. Millions of dollars were being spent on road construction and trucks would be designed more and more for use on highways, but it should be kept in mind that an army did not travel over good roads.

Machine Shop Session

Four papers were read and discussed at the Machine Shop Session held Friday morning, December 5, under the auspices of the Sub-Committee on Machine Shop Practice. These papers were: Common Errors in Designing and Machining Bearings, by C. H. Bierbaum; Lubrication of Ball Bearings, by H. R. Trotter; Thread Forms for Worms and Hobs, by B. F. Waterman; and Electric Arc Welding, by H. L. Unland. The papers by Messrs. Bierbaum and Waterman will be found in the November issue of MECHANICAL ENGINEERING. Mr. Trotter's paper was published in the October issue.

Mr. Bierbaum's paper was a discussion of the disadvantages of tight-fitting bushings, the methods of finishing brasses to provide for expansion while running, and the methods of clamping bearings during tooling. The finishing of surfaces and the importance of using sharp tools with the proper rake was also considered.

In discussing Mr. Bierbaum's paper Frank L. Fairbanks[1] stated that while the principles set forth by Mr. Bierbaum were theoretically correct, it was nevertheless commercially impossible to obtain the conditions required by these principles; and even if it

[1] Colonel, Motor Transport Corps.

[2] Captain, U. S. A.; formerly Lieutenant-Colonel, Motor Transport Corps.

[3] Consulting Engineer, New York, N. Y. Mem.Am.Soc.M.E.

[4] Chief Engineer, International Motor Co., New York. Mem.Am.Soc.M.E.

[5] Captain, Engineer Corps; Chief, Engineering Branch, Motor Transport Corps.

[1] Chemical Engineer, Quincy Market Cold Storage & Warehouse Co., Boston, Mass., Mem. A.S.M.E.

were possible to maintain a full oil film between journal and bearing this would mean a projected area so large and a rubbing speed so low that it would be doubtful whether such machine could compete with one obtaining 750 to 1,000 lb. per sq. in. by letting the metal take some of the wear and tear.

Selby Haar[1] also discussed the paper and stated that because of the small clearance or radial air gap between stator and rotor, bearings for small alternating-current motors of the induction type must be manufactured with additional limitations to those mentioned by Mr. Bierbaum's paper. A looseness in the bearing of only a few mils, he explained, would cause a considerable percentage variation of air gap around the circumference of the rotor. He further remarked that inasmuch as motors are often shifted from one class of work to another it is necessary that motor bearings be more liberally designed than plain machine bearings.

C. H. Norton[2], discussing the questions of oil filament, oil grooves, and heat, stated that he had come to the conclusion that all oil grooves were of no possible value. He referred to a pamphlet published by the Texas Oil Co., in which he said it was concluded from a series of experiments on heat and speed that the fact that a bearing is heated to about 210 deg. is probably proof that oil is in it and the surfaces are separated by fixed oil and they become cooler as the oil film becomes thinner.

Of the lubricating of ball bearings, the subject of Mr. Trotter's paper, but little is known, and this, according to the author, is chiefly due to the fact that there is no accepted method of determining the lubricating value of an oil or grease. In presenting his paper Mr. Trotter outlined a method which he has devised for this type of work. He also discussed the operating characteristics of a ball bearing and presented specifications for what he considered a satisfactory oil.

Henry Hess, in discussing the paper, suggested that the Research Committee of The American Society of Mechanical Engineers urge on Mr. Trotter the advisability of completing his investigations and that the Society aid by setting aside such funds as might be needed.

W. T. Murphy[3] said that 80 per cent of all trouble in bearings was caused by the presence in the lubricant of sand particles or other abrasives. Discussing the question of running anti-friction bearings without any lubricant, he observed that while such a procedure was theoretically correct, in practice the lubricant helped to overcome the slight friction that exists between the races of the bearings and the balls or rollers, and that there are cases where the use of grease or oil on such bearings is absolutely essential.

George N. Van Derhoef[4] challanged Mr. Trotter's conclusions as to the impossibility of there being an oil film between balls and races in a ball bearing. He observed that the research work so far conducted on oil films had been confined to bearings with much larger areas than there are in the case of balls traveling in the conventional raceway and also with surfaces with a different relative motion. He also pointed out that the difference in the coefficient of friction of lubricated and unlubricated ball bearings seemed rather to confirm the idea of an oil film existing in the case of the lubricated bearing.

H. R. Smith[5] claimed that the only practical method of gaging the lubrication qualities of an oil is by determining its viscosity value. In the case of a grease, the most important factors, he said, are the free acid—organic or mineral—or alkali, free fatty oil, solid matter, the character of the soap used and also the viscosity of the mineral oil employed in the manufacture of the grease.

Thread Forms for Worms and Hobs, by B. F. Waterman, was a discussion of both the theoretical and mechanical problems involved in the use of worm gearing. According to the author there has been a steady increase in the use of worm gearing and accompanying it a corresponding increase in efficiency and durability.

In discussing Mr. Waterman's paper Henry J. Eberhardt[1] related an experience of the Newark Gear Cutting Machine Co. which led them to generate worm wheels having an angle of side of tooth of 14½ deg. In generating a worm wheel with a fly tool, according to the Noerstedt process, the fly tool having been made with straight sides and ground to 29 deg., included angle, the worm wheel thus generated would not run with a 29-deg. worm as it would not mesh. They, therefore, concluded that the only way to generate a worm wheel was to make a fly tool or thread on the hob of the same shape as the worm.

In the discussion of Mr. Unland's address on Electric Arc Welding, the question was brought up as to whether the Boiler Code Committee would accept and pass a boiler constructed and repaired by electric welding. In this connection Mr. Unland remarked that the question of repairing boilers had been previously discussed before The American Society of Mechanical Engineers, but as yet he did not know of any conclusions ever formulated in this respect by the Boiler Code Committee. He observed, however, that this type of repair is made and passed by all the shipping bureaus, Lloyds' and the American Bureau and others, on repairs to marine boilers, provided the company doing the work has the sanction of the underwriter. Mr. Unland stated that the majority of users are in favor of the direct current for electric welding, and that in this country the accepted practice is to use uncovered electrodes, while in England and on the continent of Europe the covered electrode is in favor.

General Session

Four papers were presented at the General Session held on Friday morning, December 5. These were: Slow-Speed and Other Tests of Kingsbury Thrust Bearings, by H. A. S. Howarth; Octaval Notation and the Measurement of Binary Inch Fractions, by Alfred Watkins; Modern Electric-Furnace Practice as Related to Foundries in Particular, by W. E. Moore; and An Investigation of Strains in the Rolling of Metal, by Alfred Musso. Abstracts of all of these papers have appeared in MECHANICAL ENGINEERING, those by Messrs. Watkins and Moore in the November issue and those by Messrs. Howarth and Musso in the December.

Mr. Howarth's paper, illustrated by lantern slides, dealt with the application and tests of Kingsbury thrust bearings.

Mr. Watkins, whose paper was an argument for the adoption of a new method of measuring binary inch fractions, is a resident of England and his paper was presented by F. A. Halsey.[2] In the discussion following its presentation, Dean Benjamin brought out the fact that the question of measurement was not necessarily an academic one but rather a subject of broad interest to all engineers. Howard Richards, Jr., formerly associated with the University of China, advocated the metric system but Mr. Halsey maintained that the decimal system was hopelessly impossible as an instrument for reliable service; moreover, that the system advocated by Mr. Watkins was not a new one but merely a simplified method of using a system already existing.

The paper by W. E. Moore, on Modern Electric-Furnace Practice as Related to Foundries, was a discussion of the various features of the electric furnace which have made that type practically supreme in the field.

The paper by A. L. Musso, which was illustrated by lantern slides, dealt with one of the most important problems incidental to rolling-mill operation.

E. O. Goss,[3] in a written discussion of Mr. Musso's paper, gave the results of a series of experiments made to determine the percentage elongation and side spread of cold-rolled brass, and while the results obtained differed materially from those given in the paper, Mr. Goss was of the opinion that this wide difference was not entirely due to the difference in material.

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[1] Electrical and Mechanical Engineer, New York, N. Y., Mem. A.S.M.E.
[2] Mechanical Engineer, Norton Grinding Co., Worcester, Mass., Mem. A.S.M.E.
[3] General Manager, Standard Machinery Co., Auburn, R. I., Mem. A.S.M.E.
[4] East. Con. Engr., Dodge Mfg. Co., 21 Murray St., New York, Mem. A.S.M.E.
[5] 47 South Twelfth Street, Newark, N. J., Junior A.S.M.E.

[1] Secretary, Newark Gear Cutting Machine Co., Newark, N. J., Mem. A.S.M.E.
[2] Commissioner, Am. Inst. of Weights and Measures.
[3] Vice-Pres., Leonilie Manufacturing Co., Waterbury, Conn.

President Cooley's Address

Annual Meeting, 1919, of The American Society of Mechanical Engineers

A Survey of the Society's Organization, a Review of the Last Year's Accomplishments, and an Appeal to the Engineering Profession for National Organized Effort

IT is my pleasant duty on this occasion to tell you something of the doings of the Society during the year while I have been its President. And I thought you would also be interested to hear something about the way in which the Society does its work. For most of you, I feel certain, my story will be like the opening chapters of a new book. It will, in fact, be from the opening chapters of an old book, familiar to you in appearance, but, I dare say, one you have scarcely ever opened. I mean the Year Book of the Society.

First, however, let me tell you how much I have enjoyed the year and how much I appreciate the honor you conferred on me when you entrusted me with the responsibilities of administering the affairs of the Society. It is truly a great responsibility and growing greater with each year's growth of the Society—growth both in its membership and in its activities.

I remember well those first years, back in the early eighties, when our members were only a few hundred, and our activities confined principally to two meetings, one in the spring, the other in the winter. The contributions were chiefly the papers read at the two meetings and the discussion they provoked. Today there are over 12,000 members, 72 committees engaged in the work of the Society; 17 committees representing the Society on other organizations; 31 local sections; and 47 student branches. These are directed by a Council of 21 members assisted by the chairmen of the six Standing Committees of Administration and a paid Secretary with 76 assistants. Thus has the Society grown in the 39 years since it was organized in 1880.

The machinery of this great national society is really somewhat complicated. I assume that you are as ignorant of it as I was when I took my place at the throttle valve. Ah! happy thought! How easy to explain when the right analogy comes to one. As you know a throttle valve has two functions, one to start, the other to stop. At first I thought its most important function had to do with starting. But then I was guileless. I did not know my colleagues on the Council. "Throttle valve" is just the right word. How many times we would in our discussions have settled the affairs of the Nation had something gone wrong with the stopping function of that throttle valve; but as it happened the valve never got out of order; only individuals got "out of order."

Probably only a few of you know what the Council is. I need not hesitate to speak openly and with freedom, as knowing me as well as they do, it would not have surprised me had there been not a single member of the Council present here this evening. The fact that a number are present is evidence of the discipline to which they have been subjected; or it may be evidence of the possession of a conscience still active in pointing the way of duty. But let that pass. The Council is composed of the President, six Vice-Presidents, nine Managers, the Treasurer, and five Past-Presidents. They are a fairly quiet and orderly, not to say, modest lot of men—starting with the President at the top. But those past-presidents at the bottom! What shall I say of those past-presidents? And to think that I, too, shall so soon graduate and become one of them. But so runs the machinery of the Society. The last five presidents have a place on the Council. Thus each president has five years in which to make amends for any bad judgment he may have exercised during his one year of being first in responsibility. While these 22 men do all the voting, they do not do all the talking. There are the six chairmen of Standing Committees to be reckoned with on the floor in debate. That makes 28. But that is not all—far from it. There is also the Secretary. He is a spouting fountain—of ideas for advancing the interests of the Society, and the watchdog of its activities. No one of you knows how great is his responsibility to keep the President functioning properly. The Treasurer of the Society is the only member of the Council who sits tight and says nothing.

Now that I have paid my respects to these gentlemen, my most immediate colleagues, let me say of them that it has been a rare privilege to be associated with such men in the great work of the Society. It is no mere honor as some have thought, to be a member of the Council. It means hard and conscientious work and vast quantities of it. If you could see these gentlemen sitting long hours around the Council Board, sometimes two full days at a time, you would realize how good servants of the Society they are. And let me tell you that were it more generally known how like horses these men have to work there would be fewer candidates, when the nominations for officers of the Society are made. The Council has held in all, during the past year, eleven meetings, one of them in Pittsburgh, two in Detroit and one in Indianapolis.

To my colleagues of the Executive Committee I would pay especial tribute. They have been ever faithful in responding to calls for some emergency action. And many times I fear they have thereby been greatly inconvenienced. I was told I must choose nearby men in order to get them together, and even then I would rarely have a quorum. But I wanted to go afield a bit in my selections for the Executive Committee and bethought me of a way to break down tradition. So I invited the Executive Committee to meet me at dinner. It worked like a charm. Not a man was absent. And at none of the many meetings we have held has there ever lacked a quorum. My heart goes out in gratitude to those loyal men who have so wholeheartedly helped the President over so many difficult places.

Next in our administration machinery come the six Standing Committees of Administration—Finance, Meetings and Program, Publication and Papers, Membership, Constitution and By-Laws, and Local Sections. I do not quite know how to tell you of my appreciation of the thirty men on these six committees. The amount of time and energy they give to the Society's work is enormous—appalling, I nearly said; but the word refers to the President, who must keep in touch with their several activities. The Society should know and appreciate the great care required and given so splendidly by the groups of five gentlemen composing each of our six standing committees of administration.

To aid in its work, the Meetings and Program Committee is assisted by six sub-committees, each charged with the responsibility of securing papers and preparing programs on particular subjects for sessions at the Annual and Spring Meetings of the Society. These sub-committees are really special committees in that they may be changed from time to time to meet the need of new subject-matter for presentation at the Society's meetings.

Next come the Standing Committees—House, Library, Public Relations, Research and Standardization. The Research Committee supervises all research activities, collaborates with kindred committees of other institutions and obtains results of researches conducted in other countries. It has at present seven sub-committees which are really special committees, each engaged in the investigation of some particular subject, such as the cutting action of machine tools, fuel oils, lubrication, fluid meters, worm gearing, bearing metals, and heat transmission. The latter acts jointly with a similar committee of the American Society of Refrigerating Engineers. The report of the Research Committee by its Chairman, Professor Arthur M. Greene, Jr., read at the Detroit meeting, merits wide attention. It deals with the subject comprehensively.

The Society has naturally a large number of special committees to deal with particular problems. These are formed as occasion

demands and discharged with the acceptance of their reports. Some of them are appointed annually and thus become standing committees for the year; such for example as the Committee on Junior and Student Prizes. Others are more in the nature of permanent standing committees, such as the Committee on Increase of Membership and on Student Branches. The latter is now called Committee on Relations with Colleges.

During the past year this Committee on Relations with Colleges has, under the direction of its Acting Chairman, Past-President Ira N. Hollis, made a comprehensive study of the Society's relations with educational institutions and of student and junior prizes. The report of this committee is very complete and well worth attention. It is the result of much hard work involving extended correspondence and study of other society organizations. The Council in accepting this report put itself on record as favoring prizes other than honorary membership, now accorded to persons of acknowledged professional eminence. Life membership, in addition to being acquired for a sum of money, could be awarded for the best contribution to mechanical engineering found in the papers for one year; Junior and Student Prizes, for papers of exceptional merit; a medal, for notable invention or some striking improvement in connection with the industries; honorable or special mention, for conspicuous contributions to engineering either of a practical nature or in literature; scholarships or fellowships, for exceptional attainments in college work; a medal or special mention, for exceptional achievement by Junior and Student members.

Rear-Admiral George W. Melville left a bequest of $1000 to the Society for the award annually of a medal for the best thesis on mechanical engineering; and another gentleman has this year made a similar contribution. The Society allowed him $1500 for expenses to France as the Society's official representative at the Franco-American Congress but he paid his own expenses and added of his own money $1000, making his contribution $2500. I refer to Past-President Charles T. Main.

The National Societies can well afford to further their relations with colleges. It is impossible to do too much toward helping to shape the ideals and ambitions of the youth of our country who are soon to take our places in the engineering world. The colleges would welcome the counsel of men in actual contact with the world's affairs. These engineers are giving little attention, or none at all, to the preliminary training of the young men they take on their staffs as assistants. They are, or should be, vitally interested; and they could if they would, be of great help in shaping the curricula of engineering colleges. Whatever the practicing engineer may think of his brother the professor-engineer—and his thoughts are, I fear, sometimes none too flattering—he must not confuse his brothers with clairvoyants. While college professors may be conceded to have wonderful imaginations, they stop short of being occult. The advice of the practicing engineer would be eagerly welcomed. If he thinks of us of the near-cloth as being diviners, let him at least show his hand to be read.

It cannot be said in these days that the college man works for money. His real compensation comes from the success of his students after they leave college and enter the practical world. Their training must still, and for several years, be in progress. Their teachers only are different. If we are to achieve greatest success in our profession of engineering, that is, have it stand at the forefront in world affairs, you to whom are turned over the young men from our colleges must do your part. When you realize what your part is, you will be both willing and anxious to help the college man in his part of the work. The four years in college should not be separated, as by a wall, from the years which follow. There should in those after years be the same inspiration to high ideals of life—those quite apart from money. Our country—the whole world—never needed high ideals more than it does today.

But let me get on with my description of the Society's machinery. The Boiler Code Committee with its five sub-committees still occupies a front seat in the Society's activities. The fact that our Boiler Code has been incorporated in the laws of thirteen states and seven municipalities, is a source of great satisfaction and pride. It indicates a good work well done. The Boiler Code sub-committee on Railway Locomotive Boilers is very active. The railroads themselves through the Interstate Commerce Commission, have now sought the opportunity to coöperate in this work.

The Committee on Power Test Codes, reorganized in 1918, with 18 sub-committees, is a beehive of industry, and bids fair to rival the Boiler Code Committee for the Society's favor. Some of its sub-committees have already practically completed their work and submitted reports. Another year should get the important work of this committee well on toward completion.

Progress in various degrees is being made by other special committees. The Committees on Standardization of Feed Water Heaters, Shafting, Steel Roller Chains, have all reported progress. The Committee on Protection of Industrial Workers has recently completed jointly with the United States Bureau of Standards, an elevator code in which the Safety Committee of the National Association of Manufacturers participated. The special Screw Threads Committee and the Committee on Flanges and Pipe Fittings have been active. An international convention was recently called to meet in Paris to adopt a standard for pipe threads. This Society's official delegate is M. Laurence V. Benét, who resides in Paris; and to assist M. Benét technical advisors have been appointed from the Society's membership in various American industries engaged in the manufacture of pipe and fittings.

It will interest you to learn that standardization in general has recently taken a distinct step forward. The American Engineering Standards Committee is now, after being for several months the subject of active debate, an accomplished fact. While it is recognized that there are still several changes that could well be incorporated in its Constitution, it was considered better to get started and let experience determine the exact nature of those changes. The Committee starts off with representatives from the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society for Testing Materials, and from the Government Departments of War, Navy and Commerce. The constitution provides for admitting to membership on the Committee, representatives from other societies and associations. This Committee does not create standards. That work is left to be done as now, by bodies especially interested in some particular standard. But the Committee gives its stamp of approval and serves as the medium through which standards are passed out to the world. One of the most useful functions of the American Engineering Standards Committee will be to coöperate with similar bodies in other countries in the formation of international standards; for instance, with the industries of Great Britain through the British Engineering Standards Association. When this Committee is functioning completely such matters as the coming meeting in Paris, of the Commission on an International Standard for Pipe Threads, would be handled by the American Engineering Standards Committee.

It will be remembered that last year at the Annual Meeting, President Main, after delivering his address, fled the country. I did not at first know the reason for his precipitate haste. I could scarcely imagine that it was because of the things he said in his address, although I now know that the President can say and do things amply justifying him in seeking safety. It was, however, an honorable mission that called him away. He went abroad as this Society's representative on a Committee of the four Founder Societies which was invited by the Société des Ingénieurs Civils and the Committee of the French Engineers' Congress, with the official approval of the French Minister of Armament, Public Works and Commerce, to study with French Engineers the rehabilitation of France after the war. Out of the service rendered by this Committee has come about the appointment of a Franco-American Committee in which this Society is represented by Charles T. Main and George W. Fuller.

Other exchanges of international courtesies that have afforded us satisfaction and pleasure during the year occurred in con-

nection with the Ottawa meeting of the Engineering Institute of Canada in February and the Detroit meeting of this Society in June. Past-President Hollis went to Ottawa as our special representative and Fraser S. Keith, Secretary of the Engineering Institute of Canada, came to Detroit as special representative of the Institute.

The James Watt Centenary celebration was held in England on September 16, 1919. In response to an invitation to participate, this Society sent as honorary Vice-Presidents Messrs. J. Wilfrid Harris, Harry F. L. Orcutt, R. Sanford Riley, and Wilson E. Symons.

This Society has had the pleasure of participating in extending courtesies to members of several delegations from foreign countries who have come to this country on various missions. Official delegations have come from France, Belgium and Switzerland. In fact, our distinguished guest of the evening, M. de Fremainville, is a member of the French Engineering and Economic Mission which was invited to this country by the Chamber of Commerce of the United States. M. Schneider, the illustrious head of this Commission, was recently entertained by our sister society, the Mining and Metallurgical Society of America.

An interesting and important part of the mechanism of the Society's machine is the groups of members, known as Society Representatives, who represent this Society on other bodies. There are 17 of these groups, and the men who compose them are those who have been conspicuous in the Society's work, or have qualifications especially fitting them for the particular duties involved. These other bodies and committees are the American Association for the Advancement of Science, American Engineering Standards Committee, Classification of Technical Literature Committee, Cost of Electric Power Committee, Engineering Council, Engineering Foundation Board, International Committee on Screw Threads, International Standard for Pipe Threads, John Fritz Medal Board, Joseph A. Holmes Memorial Board, National Research Council, Naval Consulting Board of the United States, Standards for Graphic Presentation, United Engineering Society —its Board of Trustees and its Library Board, United States Bureau of Mines Advisory Committee, Western Society of Engineers, Washington Award Committee. The names themselves sufficiently describe the character of work involved making unnecessary any detailed description. The reorganization of the National Research Council on a peace basis includes its affiliation with similar bodies of other nations. The Chairman of our own Committee on Research has a place on the National Research Council.

The Regular Nominating Committee and the Tellers of Election must also be mentioned. The Nominating Committee was in the old days chosen by the President alone. But President Jacobus in 1917 inaugurated the policy, followed since, of inviting the Local Sections to make nominations from which the President could choose. But a new plan is to be followed in the future.

The Nominating Committee is to be elected by the voting membership, and tomorrow morning the Society will decide on the machinery. The proposal is to utilize the Local Sections organization for conducting the primary for nominations, every voting member being assigned to a local section for that purpose. The nominations are to be confirmed at the Local Sections Conference to be held at the Annual Meeting, after which the election will take place at the Annual Business Meeting. Thus will be insured, it is believed, a thoroughly democratic election.

In 1918 there were twenty-one Local Sections. Now there are thirty-one, an increase of ten during the year. Three of them are on the Pacific Coast. One local section in New England has five branches. This growth of Local Sections and extension of section responsibilities is one of the marked features of the Society's development. Like a wide spreading tree, the Society must have its roots and branches widespread if it is to grow and thrive. The roots must reach out into new earth and the branches out into sunshine. It is my firm belief that by increasing the importance of its sections the Society will add to its strength and vigor and render the greatest service to its membership.

As I see future development of the profession as a whole, it is important that the members of local sections of our own and other national societies should be also members of sectional and local engineering societies which embrace in their membership all engineers whether they be members of national societies or not; and which include those who work with engineers as members of their staffs, and who may not possess the qualifications for membership in the national societies. This, happily, is the plan being followed. Cleveland is a good example. There is now an arrangement, approved for trial by our Council, whereby our members who are also members of the Cleveland Engineering Society may have part of their dues to this Society remitted; that is, there is a division of dues. No doubt, considerable latitude will be permitted Local Sections in order to encourage them to work out plans for improving their own organizations. With increase in importance of Local Sections work, there will come the necessity of providing more permanent local headquarters. It has been suggested, and I believe wisely, that financial assistance should be given to local building projects through the aid of societies owning the Engineering Building here in New York, and by loans from surplus reserves. This subject may well have our earnest consideration.

One of the Sections Committee's recommendations is a Traveling Secretary whose duty it shall be to visit Local Sections and assist them in developing their plans. It is a good suggestion; but I would add to it. The President's duties have become very heavy. Notwithstanding that I have given one-quarter or one-third of my time to the duties of the office, I am sure that I have not done more than one-half of what the President should do. Among other things, it has been impossible to respond to the many cordial invitations to visit Local Sections. It has also been impossible to respond to many invitations from other national bodies to be present and participate in their deliberations and ceremonial functions. You will agree with me that these are proper and important duties of the President, and the dignity of the Society requires that they should be performed.

What I would add, therefore, is that the proposed traveling secretary be the President's representative. He could be styled "Assistant to the President." He should be a man of parts and worth a salary of at least $5000 per year. With such assistance the President could perform many of his duties in whatever part of the country he might come from; that is, it would not be necessary for him to spend so much of his time at national headquarters.

This assistant could go to the President's home and stay a week or two at a time if necessary. He could represent the President at Local Section headquarters; or by lightening the burden of routine work, enable the President to go. Nor is this all. Many of the President's duties now necessarily fall on our Secretary, already overburdened with his own duties. The assistant to the President could relieve the Secretary of many of these, but not all, of course. Certain very important duties could be performed by no one with more grace or with more complete regard for the proprieties and requirements, than by our Secretary.

In taking up the duties of President, it became evident to me after a time that pending the report of our Committee on Aims and Organization, it would be inexpedient to suggest or inaugurate any changes in the existing policies of the Society. It seemed rather a period during which the existing activities of the Society should be fostered and made as fruitful of results as possible. With this thought in mind, I undertook a study of committee work. As was to be expected with such a large number of committees, some of them were more active than others. Inactivity was not necessarily the fault of a committee. Some of the subcommittees were required to work only when called on. The work of other committees was temporarily suspended on account of the war. In a number of instances suspended committee work has been resumed.

One result of my investigation was to find frequently the same man serving on a number of committees, and only the older and more experienced members of the Society on many of the committees. While in some cases these conditions were warranted as

tending to give the best results, it seemed to me that for the good of the Society it was desirable to increase the number of individuals engaged on committee work by limiting one's membership to a few committees and by adding some of the younger men. In this way more general interest would be stimulated in the Society's work and the younger men would be trained for more responsibility later. Accordingly, Local Section officers were requested to canvass their membership for men willing to accept committee appointments. There is now on file a considerable list of men not only willing to serve but who have promised if appointed to attend to the work.

Another result of my investigation was to find the membership of many of the committees confined to within reaching distance of national headquarters here in New York. It is absolutely necessary, in a number of cases, to have at least a majority membership living nearby. The Executive Committee, the Finance, the House, the Library and the Membership Committees are examples. It is not advisable, in general, to have members of a committee come from widely separated parts of the country. It should be possible for them to get together without too great sacrifice of time consumed in travel, and without too great expense, which in most cases must be borne by the members personally.

It appeared that a solution of the difficulty might be found in choosing committee members with respect to localities. For instance, an automobile committee might be centered in Detroit and embrace Buffalo, Cleveland, Toledo, Jackson and Port Huron. A petroleum committee might be wholly from the Oklahoma or the California oil districts. A machine-tool committee might be wholly from the Ohio or the New England district, and similarly for committees on other subjects. A natural way with the increased importance of our local sections would be to choose the membership committee wherever practicable from the members of a particular local section. The local section itself could be held responsible for the work of the committee. The membership of such committees need not be confined to this Society. Indeed, it might be well, and in the interests of the Society as well as the work, to appoint some non-members. If they become greatly interested they might become members later. Committee work is of first importance in the Society, and should be well cared for. When it is of high order great credit comes to the members of the Committee and to the Society. It is the good work done by its members that enables the Society to occupy and hold its high place in the world. The honor of the Society is the honor of its members. The Society can give back only what its members put in both in kind and in quantity.

Of equal importance to that of Local Sections, if not greater, are the Society's publications. It is through them that the Society gives back to its members what they contribute in money and in work. Its journal has been rechristened and is now called MECHANICAL ENGINEERING. It is the medium through which the membership at large can keep in touch with all Society activities, and become promptly informed on important engineering topics discussed at the annual and spring meetings and at the Sections' meetings throughout the country. During the year the Society has acquired the ownership of "Engineering Index" which it has greatly enlarged, and in which now appear regularly reviews or titles of articles from over eleven hundred periodicals properly classified and indexed. The Council has recently authorized an increase in the scope of the Journal so that it can be of still greater service to the membership.

With the desire to take part in and help solve, so far as it could properly, the industrial troubles of the country, the Council early in the year directed the appointment of a committee of seven to investigate and report on the feasibility of the Society actively participating in industrial questions. This committee made its report in February, advising that inasmuch as the constitution of the Society set forth as its object "to promote the Arts and Sciences connected with Engineering and Mechanical Construction," it was inexpedient to take any active part as a society in industrial matters; but that it was highly important that the members as individuals, or in their business capacity, should take such part as they could.

Believing that it would be helpful to the membership to receive the results of investigations of industrial conditions the Council in April authorized affiliation with the National Industrial Conference Board and appointed a representative on the Board. The propriety of the Society's holding such relations being later questioned the Council in October directed the appointment of a committee to report on the question of retaining our membership. This Committee, while unanimously commending the work of the National Industrial Conference Board was of the opinion that the Society should not hold membership in any other society or organization. The Council, therefore, withdrew from the National Industrial Conference Board at its November meeting held on December 1.

By far the most important work of the Society during the year has been that of its Committee on Aims and Organization. Inasmuch as the report of this Committee has been sent out to the membership and is to be discussed and disposed of at this annual meeting, I have not deemed it necessary, or even proper, to do more than call your attention to it and to urge you to take part in its consideration when presented. Suffice to say that certain recommendations of the committee have already had the attention of the council since they were favorably considered by the Society at its spring meeting in Detroit. I refer particularly to the development of Local Sections, the encouragement of Professional sections and the enlargement of the scope of the Society's journal, MECHANICAL ENGINEERING. We are all most appreciative of the work of this Committee. Theirs was a hard task, and while they would have welcomed an opportunity to carry their work further and perfect it, the Council thought that the Society would do well if it agreed upon and adopted even a few of the large number of recommendations made.

A most important part of the work of our Committee on Aims and Organization was its coöperation with similar committees of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, and the American Institute of Electrical Engineers. A joint committee of these four Founder Societies has held several meetings to consider and agree upon certain fundamental things as the basis for closer coöperation in the future. Without in any way sacrificing their identity and purpose, and leaving the chief aim of each to be pursued independently, it has been agreed that a comprehensive national organization or council of engineers should be created to be composed of representatives of local, state and regional societies. Further, that this organization be so framed as to include allied technical societies; and that coöperation of these several bodies in technical activities, and affiliations of local organizations for general public-service and welfare work be encouraged. This joint committee also recommends that the bill to create a National Department of Public Works receive the active support of all engineers.

Every thoughtful engineer will recognize the importance of these recommendations. The engineer has in the past been too much of an individualist. He is at heart a idealist. He lives in the things he creates, and often his chief reward is the satisfaction he enjoys from work well done rather than pecuniary. It is a splendid quality of heart and mind that enshrines the engineer. It harks back to those earlier days when respect for one's achievements and personal character measured success rather than the dollars amassed. But to keep one's place in these modern days requires that the game be played in accordance with prevailing rules. Thus the engineer must perforce conform to these rules if he would exert his fullest influence. It is organized rather than individual effort that gets ahead today. Only the individual who can direct and control organized effort stands out as an individual. He is the general in command of forces.

The one criticism of the engineering profession, as I see it, is that there are too few generals. The positions of high command too often go to others who are rarely themselves engineers but who constantly make use of engineers in framing and executing their plans. That is to say, the engineer, while he has the knowledge and skill required to plan and build structures utilizing Nature's material forces for the benefit of mankind, has appar-

ently given but little indication that he possesses the knowledge and skill required to handle human forces for the benefit of mankind. It would appear that that kind of leadership does not appeal to the engineer. He has made the instrument, even composed the music, which others have played to sway the multitude. In short, the engineer, if he has the qualities for leadership, has not been leading, except in his own field and amongst his own kind where of course he stands preeminent.

The world today needs a Moses to lead it out of the Wilderness. Moses must have been an engineer. That job of his in the Red Sea would indicate that he was an hydraulic engineer. Can the engineering profession aspire to such leadership as is today needed? No one knows. We think it can. But it would appear that the engineer has not been thought of in that connection. Why? Simply because he has in the past taken so little part in public affairs outside his profession. Here then lies the opportunity, the first step being to organize nationally and do the things recommended by our Joint Committee of the four national engineering societies.

One of the things recommended is the active support of the bill in Congress to create a National Department of Public Works. Such a department would at once bring the engineering profession before the eye of the world. It is such a normal and proper move that one would think it would carry itself. But it will not. You can be sure of that. It is forty years since the effort to secure such a department was first made. It failed as have all subsequent efforts for want of being properly pushed. And who is to push? You, gentlemen of the engineering profession. Not one, nor a few, but all of you and all together, and at this particular time.

I am now come to near the end of what I had in mind to say to you. There are other things that should be added to make my story of the year's doings complete. But something must be left for my successor in office to say next year. A president's address is not, I fear, the best medium of conveying a message to the multitude. It partakes more of the nature of an embalming process of ideas. It will find its mausoleum in the TRANSACTIONS. Some thousands of years hence it will be discovered, and the world of that day will comment on it much as we now do on the papyrus from the tombs of Egypt. But I have had great pleasure notwithstanding, in preparing my address.

Our worthy editor has for several weeks been keen to discover the title of my address. He was somewhat perturbed when I informed him that there was to be no title; that I proposed to be free, up to the last moment, to write what I pleased. The fact that I have succeeded in eluding him I consider some accomplishment, as you would agree did you know him as well as I do.

And now my adieus. It has been for me a happy year. I am grateful to you for your confidence, and your good will. It has brought forth the best that is in me. While I have many times failed to measure up to what I consider a proper specification for a president of The American Society of Mechanical Engineers, I have the satisfaction of feeling that I have stretched myself to the utmost in an effort to render all the service of which I was capable.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 228, 230, 252, 253, 256-261, inclusive, as formulated at the meeting of October 24, 1919, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 228

Inquiry: Will wrought-iron material made by the puddling process be acceptable under the Boiler Code Rules for use in superheater construction where the requirements in the Code specify wrought steel or cast steel?

Reply: Where the Boiler Code specifies wrought steel or cast steel for superheater construction, the intent was to prohibit the use of cast iron. It is also the opinion of the Committee that puddled wrought iron that will meet the requirements in the specifications for wrought iron in the Code will be a suitable material.

CASE NO. 230

Inquiry: In the case of a water-tube boiler of the water-leg type, using large tapered connections from the rear header to the drum, is it permissible to weld the flanged edges of the water-leg sheets instead of butt-strapping them, and also the longitudinal joint of the tapered connection piece if it is amply braced crosswise by staybolts? These welded joints would not be under tension, as the staybolts take all of the pressure load and the possibility of breakage of these staybolts is negligible.

Reply: It is the opinion of the Committee that this cannot be done and comply with the requirements of the Code. The safety of the structure may be dependent upon the weld to the extent that the interior stresses in the weld, which would be relieved if rupture should take place, may throw suddenly upon the nearest staybolts, excess stresses which may cause the staybolts to fail in series.

CASE NO. 252

Inquiry: Is it necessary under the requirements of Par. 186 of the Boiler Code, where door-hole flanges are to be welded and the stress due to the steam pressure is to be carried by the adjacent stay-bolting, to consider any limitation on the staybolt pitch to secure proper distribution of the load from the door-hole flanges to the staybolting?

Reply: It is the opinion of the Committee that under the requirements of Par. 186 the door-hole flanges of the furnace and exterior sheets may be joined by autogenous welding, provided these sheets are stayed or otherwise supported around the door-hole opening, and provided that the distance from the flange to the surrounding row of stays or other supports does not exceed the permissible staybolt pitch, as per Par. 199.

CASE NO. 253

(Annulled)

CASE NO. 256

Inquiry: Can a vertical fire-tube boiler be constructed with an unstayed furnace from 36 to 38 in. in diameter with butt-strap longitudinal seams as required in Par. 239 of the Boiler Code?

Reply: It was not the intent of the Boiler Code that the requirements for longitudinal seams of furnaces between 36 and 38 in. inside diameter should apply to the unstayed furnaces of vertical firetube boilers. Such furnaces over 36 in. inside diameter should be fully staybolted, as it is necessary to use lap-riveted longitudinal seams in this type of furnace. Butt-strap seams may be used only in horizontal furnaces where the seams can be placed below the grate.

CASE NO. 257

Inquiry: Will a specially constructed water gage with an automatic-valve-closing device, arranged to be operated by a balanced pressure attachment depending for action upon the breakage of the water glass, be considered under the rules of the A.S.M.E. Boiler Code as an automatic water gage, in which the automatic shut-off valves must conform to the requirement of Par. 427?

Reply: It is the opinion of the Committee that the requirements of Pars. 292 and 427 of the Boiler Code apply specifically to automatic shut-off valves on water gages and not to exterior automatic devices which may be provided to close the valves. If the automatic closing device is not incorporated into the construction of the shut-off valves, the requirements of these paragraphs do not apply.

CASE NO. 258

Inquiry: *a* In large hot-water heating boilers which under the requirement of Par. 335 of the Boiler Code must be constructed under the requirements for power boilers, is it necessary that such requirements as covered in Pars. 291 and 315 shall apply?

b Was it the intent of Par. 349 of the Boiler Code to cover the possible contingency of the necessity of a water-relief valve discharging steam, provided the boiling point has been passed, by the bursting of the diaphragm, thereby increasing the capacity of the water-relief valve?

c Would it be assumed that the safety of the structure would be dependent upon the strength of a weld made in a header of a Hawley down-draft furnace attached to the shell by means of pipe connections from each header, and could such a header be welded and a patch strap then applied over the top of the weld, to take the strain of a joint which is in tension?

Reply: *a* It is the intent of the requirement in Par. 335 that only such portions of the rules for power boilers shall apply to hot-water boilers as refer specifically to constructional details. The requirements for some of the fittings and trimmings for steam power boilers are obviously not applicable, so that in such cases the rules for hot-water heating boilers shall apply.

b It was not the intent of Par. 349 that the diaphragm of a water-relief valve should break after the valve opens.

c It is the opinion of the Committee that this is a question of repairing boilers. The Code gives certain recommendations in regard to the use of autogenous welding for repairs, but does not deal with the general subject of repairing which must, in each case, be taken up with the local state or municipal inspectors.

CASE NO. 259

Inquiry: Is it allowable under the requirements of the A.S.M.E. Boiler Code to fit a high-pressure steam boiler with a 4-in. blow-off connection, in case it is to be used initially for low pressure steam service, or will it be necessary under the requirements of Par. 308 to apply two or more 2½ in. blow-off connections for the return connections to the boiler?

Reply: It is the opinion of the Committee that the boiler could be fitted with the 4-in. blow-off connection when in use for hot-water heating and, when converted to a steam boiler, a reducing fitting could be used at the 4-in. opening to reduce to the pipe size necessary for the blow-off connection.

CASE NO. 260

Inquiry: Is the requirement of Par. 185 of the Boiler Code, relative to planing down the girth joint, applicable to a special type of boiler formed of an h.r.t. shell with a water-tube element over which the gases pass before coming in contact with the h.r.t. shell?

Reply: Par. 185 applies only to horizontal return tubular boilers and does not apply to a combination design of fire and water-tube boiler as described. In such a boiler the girth joints are not as directly exposed to the heat of the fire as in the case of the h.r.t. type of boiler.

CASE NO. 261

Inquiry: What is the stress allowable under the requirements of the Boiler Code for unwelded solid stays more than 20 diameters in length?

Reply: It is the opinion of the Committee that the stress should be that given in item *c* in Table 5 of the Boiler Code, which is 9500 lb. where the lengths between supports do not exceed 120 diameters.

PROPOSED CODE FOR AIR TANKS AND PRESSURE VESSELS

For nearly a year a Sub-committee of the Boiler Code Committee has been engaged in formulating rules for the construction of air tanks and pressure vessels, to be known as Part I, Section IV, of the A.S.M.E. Boiler Code. It is the object of this section, which is devoted to pressure vessels other than fired steam boilers, to secure safe construction and at the same time to so establish the rules that the requirements are within practical working limits.

The work of the Sub-committee to which this task was assigned began in April, 1919, and the preliminary report which follows is the result of a careful and painstaking study. The Sub-committee consists of the following members:

E. R. Fish, *Chairman*	S. F. Jeter
Wm. H. Boehm	Wm. F. Kiesel, Jr.
C. E. Bronson	James Neil
E. C. Fisher	

The preliminary report was ordered printed by the Council of the Society with a view of having it discussed by the membership and the public at large. Discussions should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y.

A. S. M. E. BOILER CODE

PART I—SECTION IV

PRELIMARY REPORT ON RULES FOR THE CONSTRUCTION OF UNFIRED PRESSURE VESSELS

NOTE: When this Section is incorporated in the Boiler Code, it will be desirable to add the words "AND OTHER PRESSURE VESSELS", at the top of the front cover and of the title page and on page 3 of the Code. Also the sentence in italics on page 3 will be changed to read, as follows:

These rules do not apply to boilers and other pressure vessels which are subject to Federal inspection and control.

Also to insert, after bracket in line beginning Part I, the following:

SECTION IV—UNFIRED PRESSURE VESSELS

DEFINITIONS

The vessels to which these rules apply are divided into two classes:

Class A—Vessels for containing liquids above the atmospheric boiling point, inflammable substances, or any gas, and limited in size to those over 6 in. in diameter, more than 1.5 cu. ft. in volume and carrying over 15 lb. pressure per sq. in.

Class B—Vessels for containing liquids, the temperatures of which are under control so as to be below atmospheric boiling point and limited in size to those over 9 in. in diameter, more than 4 cu. ft. in volume and carrying over 30 lb. pressure per sq. in. but not to exceed 100 lb. pressure per sq. in. For pressures over 100 lb. per sq. in. the rules for Class A vessels apply.

MATERIAL

These vessels may be constructed of any metal complying with the following rules:—

The maximum allowable working stress used in any of the

metals selected shall be determined by the following formula:—

For Class A Vessels: —

$S = 0.0125\ E\ (e + 8)$ but not more than $0.4\ E$

For Class B Vessels:—

$S = 0.0125\ E\ (e + 16)$ but not more than $0.65\ E$

where

S = Maximum allowable working tension stress, lb. per sq. in.;

E = Elastic limit of material used:

e = Elongation of material used, in per cent, in 8 in.

Working stress in rivets in single shear shall be taken as 80 per cent of S;

Working stress in rivets in double shear shall be double that of single shear.

Staybolt values for allowable stress per sq. in. of net section shall be taken as follows:—

When e is not over 10 per cent = 60 per cent of S;

When e is from 10 to 20 per cent = 70 per cent of S;

When e is over 20 per cent = 80 per cent of S.

Class A Vessels may be constructed of materials specified in the A.S.M.E. Boiler Code (Edition of 1918), in which case the formula above given need not be used.

Class A Vessels shall be built in accordance with the rules of construction, which apply, of the A.S.M.E. Boiler Code (Edition of 1918) except Par. 186 which shall read as follows:—

The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 65 per cent of the tensile strength of the plate.

and Par. 269 to 328, inclusive.

Class B Vessels may be constructed of material specified in the A.S.M.E. Boiler Code (Edition of 1918) in which case the formula above need not be used.

For Class B Vessels, steel of untested tank quality may be used, assuming the tensile properties below:—

Tensile strength, lb. per sq. in.	48,000
Yield point, lb. per sq. in.	25,000
Elongation in 8 in.	20 per cent

All Class B Vessels shall be constructed in accordance with the rules of construction, which apply, of the A.S.M.E. Boiler Code (Edition of 1918) with the following exceptions:—

Par. 180—change FS = 4.

Par. 186—rewrite as follows:—

The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 65 per cent of the tensile strength of the plate. The ultimate strength of a joint which has been properly welded by the autogenous process, may be used in Class B pressure vessels only and shall be taken as 50 per cent of the tensile strength of the plate.

Par. 187—change 36 in. to 48 in.

Par. 188—change 36 in. to 48 in.

Par. 190—omit entirely.

Par. 195—change formula as follows:—

$$t = \frac{5 \times P \times L}{2 \times \mathrm{TS}}$$

Par. 210—holes may be punched full size.

Par. 253—rewrite as follows:—

All rivet holes may be punched full size.

Par. 254—omit entirely.

Par. 256—omit entirely.

Par. 257—rewrite as follows:—

Calking shall be done with a round-nosed tool.

Par. 262—rewrite as follows:—

Manhole plates may be of wrought steel, steel castings or of cast iron.

Par. 263—omit entirely.

Pars. 269-328—omit entirely.

No drain or blow-off shall be less than ¾ in. pipe size.

Safety Appliances. All pressure vessels shall be provided with such relieving, indicating and controlling devices as the industry in which they are employed or use to which they may be put shall require to insure their safe operation. All such devices shall be so located and installed that they cannot possibly be rendered inoperative. The relieving capacity of safety valves shall be such as to prevent a rise of pressure in the vessel of more than 6 per cent above the maximum allowable working pressure.

Supports. All vessels must be so supported as to equally distribute the stresses arising from the weight of the vessel and contents. Class A Vessels must be so arranged that the entire interior and exterior of the vessel may be thoroughly inspected. In the case of vertical vessels, the bottom head, if dished, of cylindrical vessels must be with the pressure on the concave side to insure complete drainage.

(Par. 325) Lugs or brackets, when used to support a vessel of any type, shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on steel or iron rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. 15 and 16 of the Boiler Code.

Corrosive Chemicals. All pressure vessels which are to contain substances having a corrosive action upon the metal of which vessel is constructed should be designed for a pressure in excess of that which it is to carry to safeguard against early rejection.

Class A Vessels shall be stamped in accordance with the A.S.M.E. Boiler Code (Edition of 1918), Pars. 331-332.

Class B Vessels shall be stamped in accordance with the A.S.M.E. Boiler Code (Edition of 1918), Pars. 376 and 377.

$$\begin{matrix} \{ & \text{A.S.M.E.} & \} \\ \{ & \text{B} & \} \end{matrix}$$

Location of Stamps. Location of tank manufacturer's stamps to be as follows: plain cylindrical tanks, and all other tanks not of a steam boiler type shall have at least one stamp, all stamps to be plainly visible when the tank is completed. On a tank with a manhole, said stamps shall be close to the manhole opening; on a tank without a manhole, close to the handhole; and on a tank without either a manhole or handhole, in a conspicuous place.

The tank builder's stamp shall not be covered by insulating or other material.

According to a recent article in *Oil News* the British-Inter-Departmental Committee on the production and utilization of alcohol for power and traction has recommended that the British Government study the possibilities of this form of fuel.

In the British Empire, according to the committee, there are vast prospective sources of alcohol in the vegetable world, although in the United Kingdom itself production from these sources is now and is likely to remain small. Synthetic production, however, especially from coal and coke-oven gases, is promising. The Committee also states in its report that "to the enormous growth of road motoring during recent years, especially in the United States of America, there will now be added the requirements of high-grade petrol for aeroplanes and airships, to which no limits can be assigned. Whilst it is impossible for us to forecast the development of total petrol consumption for all countries and all purposes, facts are not wanting to indicate the likelihood in the not distant future of so great a pressure of demand as to cause at any rate a very high level of prices, and we are satisfied that close investigation should now proceed with the object of providing alternative supplies of motor fuels derived from new or supplementary raw materials.

"We are satisfied that the time has come for government action, which should pay due heed to both current and prospective prices for petrol, or other petroleum products, benzol, and alcohol motor-fuel or its admixtures.

"We have received exhaustive technical evidence from representatives of the Ministry of Munitions concerning the investigations made by them during the war in respect of the extraction of ethylene from coal and coke-oven gases, and concerning quantitative results so obtained. The testimony of witnesses and records of work done indicate that there is available in Great Britain a large potencial source of power alcohol, but further investigations are necessary in this connection, particularly as regards the conversion of ethylene into alcohol, before definite figures as to quantities and price can be given."

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Research on the Pacific Coast and at the Naval Experiment Station at Annapolis

DURING the past months the Committee on Research of the San Francisco Section has been active in sending out inquiries regarding research and the report below together with a letter of transmittal from Prof. W. F. Durand gives an excellent idea of research conditions in that portion of the United States.

When the Committee of the Society planned its present work it was not expected that we would receive information regarding research for private development purposes. This work in many cases represents a large expenditure of money and the Committee does not desire to publish any of this information until the proper time arrives. It has hoped that when such information is properly protected it will then be given to the profession as a contribution to our scientific knowledge.

The General Committee feels that the report of the San Francisco Committee is a most excellent one in bringing to our members problems on which work is being done and for which solutions are desired by engineers of the Pacific Coast.

The conditions for commercial testing at the Naval Experiment Station are described in a statement prepared from a note received from the Station. It is given here for the information of our members having apparatus or materials suitable for naval service.

LELAND STANFORD JUNIOR UNIVERSITY,
STANFORD UNIVERSITY, CAL.,
October 15, 1919.

PROF. ARTHUR M. GREENE, JR.,
Chairman, Committee on Research, A.S.M.E.,
29 West 39th St., New York, N. Y.

MY DEAR PROFESSOR GREENE:

After some delay caused by the special rush of work at the opening of our academic year, I am handing you herewith a brief résumé of the replies received to date from the circular letters which we sent out regarding problems under investigation or suggested for research in San Francisco and vicinity.

Out of nearly two hundred letters sent out, only about a dozen replies have been received of sufficient significance to justify listing with reference to the purposes of the survey.

From what I learned by private conversation, however, it is perfectly clear that this is only a small part of the investigation and research work which is actually going forward. Many people stated that they did not feel at liberty to state the character of the work on which they were occupied, simply for the reason that they considered it confidential in character and of possible commercial value, and were, therefore, not disposed to make any report of the matter which might give any indication to other people, possibly competitors, regarding the work on which they are occupied.

I anticipated precisely some such result as this, although it was impossible to tell before the event just how much we might be able to develop under conditions involving commercial competition and the safeguarding of private interests.

It is evident that the amount thus actually developed by no means represents adequately the amount of research and investigation work on which mechanical engineers in this vicinity are occupied, but under the circumstances it seems to represent the best showing that can be made so far as a public record or statement is concerned.

I must confess to some doubt as to the extent to which our Committee can be of very much significance in connection with such work of research and investigation, due primarily to the disinclination of people to talk about work of this character, and the very natural desire to safeguard in every possible way personal and private interests. However, something useful may perhaps develop, and we shall always be glad to coöperate with the work of the general committee in so far as we possibly can.

Sincerely yours,

(Signed) W. F. DURAND.

SURVEY OF ENGINEERING RESEARCH, SAN FRANCISCO AND VICINITY

PREPARED BY THE RESEARCH COMMITTEE OF THE SAN FRANCISCO SECTION OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

1 *a* Confidential metallurgical research work, the character of which cannot be made public.

b Suggestion of the following subjects as important for investigations:

1 The development of a coke suitable for making pig iron on the Pacific Coast.

2 A continuous process for producing spelter.

A large part of our spelter is produced in Kansas and Oklahoma where natural gas used to be cheap. The old-style distillations furnace is used. Gas is becoming more expensive now and these furnaces are costly and wasteful. Zinc ore is produced largely in the west and it is a long haul to Oklahoma and Kansas. During the war some ore was shipped from Australia to the Kansas smelters. Electrolytic zinc is not as satisfactory a solution as had been hoped for.

Fuel gas can be obtained by partially coking the coal in a by-product oven so that the by-products would pay for the gas. Or pulverized coal might be used. It should not be difficult to devise mechanical means so that a continuous distillation could be obtained. This would eliminate the wasteful charging methods and the loss of time and retorts. Considerable study could be devoted to the production of a more satisfactory retort.

2 *a* Confidential developments relating to rotary gas compressors and the application of same to the various industrial uses such as: vacuum pumps, air compressors and refrigerating apparatus.

b Suggestion of development of heating buildings by reversal of thermodynamic cycle, using cheap electrical energy and low-temperature air as input with a delivery of high-temperature heat as output, measured in amount by the electrical input divided by the thermodynamic efficiency. Reference is made to Lord Kelvin's suggestion of possibilities along this line.

3 Investigation of certain forms of hydraulic dynamometers as a transmission device.

4 Development of a special or modified form of Diesel engine, cycle, intended to use kerosene and distillate. The special significance of this development lies in the possible extension of the use of kerosene or distillate for many purposes now requiring gasoline, and the resultant liberation of such amounts of gasoline for use in aeronautic and automobile engineering where the higher grades are especially desirable.

5 Development of proper type and mounting of ball bearings for deep-well and centrifugal pumps.

6 Development of a grade of steel suitable for pins for buckets on gold-dredging machinery. Pins vary in diameter from 3 in. to 7⅝ in. A few years ago a pin lasting nine months was considered as giving good service. With improved grades of steel, pins have now been in continuous service for three years.

7 Investigations on airplane propellers in connection with the National Advisory Committee for Aeronautics, the results of which are published in the annual reports of that Committee.

8 An investigation on the wear of gear teeth under loaded conditions, and including the influence of the following variable features:

a Varying intensity of load
b Varying materials
c Varying tooth forms
d Lubrication.

9 Investigation of the economic possibilities involved in the use of steel belting as a substitute for leather, and with special reference to the development of a satisfactory form of joint.

10 Research relating to the problem of the transfer of heat between fluids, vapors, and gases, and with special reference to the development of satisfactory commercial apparatus for such purposes, based on sound engineering principles. This research is intended to include a study of the transfer of heat between metal surfaces and fluids of widely varying viscosities and specific heats and including vapors and gases. In a detailed way the investigation will bear especially upon the transfer of heat between metallic surfaces and petroleum oils and water.

11 A general investigation relating to the problem of the development of a steam power plant, especially designed to meet the requirements of the self-propelled vehicle. This involves engineering research along the following lines:

a A system of combustion, using for fuel kerosene and cheaper grades of fuel such as stove oil, etc. A successful system for this work requires complete combustion, as the formation of soot or carbon deposits would be objectionable.

b In the construction of the combustion system, to make it entirely automatic and subject to control by boiler conditions, so that the temperature of superheat, the pressure of the steam and the supply of feedwater to the boiler, would all be automatically controlled, so as to maintain uniform con-

ditions of operation. This involves the development of an automatic ignition device, so that by simply closing an electric switch, completing the circuit through the automatic control, the fire would be started under the boiler and brought under full control of the automatics to bring about the above results.

c A fuel and fire automatic control, so as to maintain within the boiler uniform temperature of superheat, of steam pressure and the necessary feedwater supply.

d The development of a new type of high-pressure boiler, especially developed to furnish steam at a high superheat, and at a maximum thermal efficiency.

e The development of a new type of steam engine which will have high economy, great flexibility of control and be able to utilize with maximum economy high-pressure steam with high superheat.

12 Investigations relating to improvements in electric furnaces, with special reference to the following applications:

a For the melting of steel scrap into steel castings.

b For the melting of steel scrap and ferroalloys into tool steels.

c The heat treating of steel castings, either annealing or tempering as the requirements may be.

d The melting of non-ferrous metals in commercial castings, particularly marine work.

Commercial Testing at the Naval Experiment Station, Annapolis, Md.

The Bureau of Steam Engineering of the United States Navy conducts tests at its Naval Engineering Experiment Station of such engineering apparatus and materials as give promise of proving desirable for use in naval service. The requirements for making these tests are:

a That the material or device offered shall have definite application to naval needs.

b That the Government shall not be involved for any expense whatever either for the cost of the test, the material or apparatus tested, the shipment charges or damage to material or apparatus in consequence of the test.

c That the result of the test shall not be used for advertising purposes.

Application for test should be made in writing to the Bureau of Steam Engineering, U. S. Navy, Washington, D. C. If the nature of the article to be tested is not known or has not been explained in a personal interview the application must be accompanied by a complete description and blueprints, if necessary, for a thorough understanding.

If the test is authorized the applicant will be put into communication with the Superintendent of the U. S. Naval Academy, Annapolis, Md., who will furnish information as to any special requirements in connection with the test, such as number, size, and material of the article to be tested, steam pressure, etc., and will also designate the deposit which it will be necessary to make to cover the probable cost of test.

All necessary information having been received, the apparatus to be tested will be shipped, prepaid, addressed to the "Supply Officer," U. S. Naval Academy, Annapolis, Md., and plainly marked "For Engineering Experiment Station." A check will also be forwarded to the Superintendent of the Naval Academy, drawn to his order and covering the amount of deposit designated. Any unexpended portion of this deposit will be returned upon completion of the test.

The applicant will be allowed to have a representative present at all tests made on the apparatus submitted by him, and he or his representative may make suggestions or objections concerning the method of carrying out the test. Such suggestions will be followed so far as practicable and consistent with the purpose to obtain complete and conclusive data. The test authorities will be free to submit the apparatus or material to any test which in their judgment may be desirable to determine its suitability under any special requirements for use in the naval service, whether such tests have been contemplated by the applicant or not. When the applicant objects in writing to any proposed test on the ground that he believes the apparatus or material would be injured thereby, the particular test will not be made and the objection will be made part of the record of the test.

All applicants must agree in writing to accept the conditions of the test set forth above and must further agree in writing that they will accept the results of the test as final and that they will not apply for a retest of articles or material until such changes have been made which will give reasonable promise of overcoming defects. This agreement in writing should be forwarded to the Superintendent of the Naval Academy together with the deposit mentioned in Par. 5.

Upon completion of test, a copy of the report thereon will be furnished the exhibitor by the Bureau of Steam Engineering.

For further particulars address Chief of the Bureau of Steam Engineering, Navy Department, Washington, D. C.

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulæ or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigator do not warrant a paper.

Electric Power A6-19. Electric Ranges. C. W. Pieper is the author of a Bulletin No. 2 of the Engineering Experiment Station at Purdue University on electric ranges. Seven electric ranges were tested. The time taken to preheat the ovens and to heat 3 lb. of water within the oven to boiling point varied from 12 min. to 45 min., the oven temperatures varying from 420 to 530 deg. fahr. On opening the oven doors for 45 sec. the temperature fell about 100 deg. fahr. This was regained in about two minutes. The ovens required varying amounts of power to care for radiation. The most efficient oven required 100 watts to hold it at 200 deg. F., 300 watts for 395 deg., 500 watts for 550 deg. and 700 watts for 680 deg., while the less efficient oven required 220 watts for 200 deg., 610 watts for 395 deg., 1220 watts for 550 deg. The surface burners, which are in the form of porcelain hot plates, gave from 51 to 69 per cent efficiency in the evaporation of water, while in heating water the efficiency varied from 8 to 51 per cent. To bake biscuits about 1 kw-hr. is required. Cake requires 14/10 kw-hr.; bread 13/10 kw-hr. The following table gives the results for power supply of families of different sizes when the cost of power is 11 cents for lighting and 6 cents for the first 10 kw-hr. and 3 cents per kw-hr. beyond this. The form of load curve is given in Fig. 1.

Size of Family.	No. of Rooms.	Time; Month & Day.	Range, kw-hr.	Light, kw-hr.	Total kw-hr.	Total Bill.	Net Range Bill.
2	6	1-14 to 2-21	36	11	47	$2.29	$1.19
2	6	3-24 to 4-24	71	11	82	3.26	2.16
3	7	1-22 to 2-21	112	20	132	5.06	3.06
5	6	3-22 to 4-22	54	58	112	4.24	1.56
5	8	2-23 to 3-24	101	32	133	5.31	2.11
7	10	2-21 to 3-21	108	51	159	6.53	1.43
7	10	12-22 to 1-22	167	57	218	8.30	2.60

The Bulletin describes the various ranges tested and discusses the advantage of electric ranges. Engineering Experiment Station, Purdue University, Lafayette, Ind. Address C. H. Benjamin, Director.

Lubricants A2-19. Cutting Oils from Machine Tools. Diseases have been caused by infections in cuts and abrasions in the skin of machine operators from oil used on machine tools. This has been the subject of a report by Lieutenant-Commander A. G. Zimmermann of the Ordnance Department, U. S. Navy. His report quotes Bulletin No. 2 of the Department of Scientific and Industrial Research, No. 15 Great George St., Westminster S.W.-1, London, England. This Bulletin is a memorandum on Cutting Lubricants and Cooling Liquids, their Purposes, Properties, Composition, and the second part of the paper is on the Skin Diseases Caused by Lubricants.

Oil rashes are caused by:

(*a*) The plugging of glands of the hair follicles.

(*b*) Mechanical injury to the skin by metallic particles.

Any injury to the skin may allow germs to enter and cause septic infection. To prevent disease the workmen must keep perfectly clean, washing with hot water and soap and scrubbing brushes and not washing in the cutting compounds. The lubricant must be kept clean by constantly removing the metal particles by filtration and the machines must be kept clean by frequent removal of all old lubricant and dirt. The lubricants should be treated with disinfectants or antiseptics, although the use of some of these promote skin poisoning. It is well to sterilize the cutting oil by heat, and 300 deg. fahr. is suggested for the temperature of this heat. Any workers with septic infection of the hands should not be permitted to work. Workmen should be instructed to refrain from expectorating in the pans of the machines. The treatment for the blocking of the glands is frequent washing with soap and water followed by the use of zinc oxide and starch powder. Septic infections in cuts should be treated by suitable

antiseptic dressings. Certain persons are more susceptible than others.

This report may be obtained from the Department of Scientific and Industrial Research, London, England.

Commander Zimmermann also quotes from the "Traveler's Standard" of July, 1918, prepared by the Engineering and Inspection Division of the Travelers' Insurance Company. This article speaks of the contamination of the oil from sputum. The report suggests repeated heatings to kill the germs and also repeated cleanings of the system. The dressings used for cuts should be such that the oil cannot further enter the broken skin. For that reason a collodion dressing may be quite useful. In many cases a rubber cot is advantageous.

One per cent of carbolic acid may be added as a germicide, but an excessive amount of acid will cause poisoning. It must be remembered that workmen have their hands wetted with the cutting fluid for hours at a time. Tanks used to hold the cutting oils should be covered so that animals may not drop in and become decomposed.

An investigation of oil samples from a machine tool showed the presence of bacteria found in sputum. It is important that notices against spitting in oil pans should be posted.

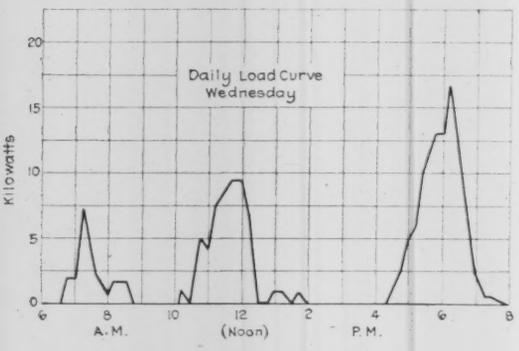


FIG. 1 FORM OF LOAD CURVE OF ELECTRIC RANGE

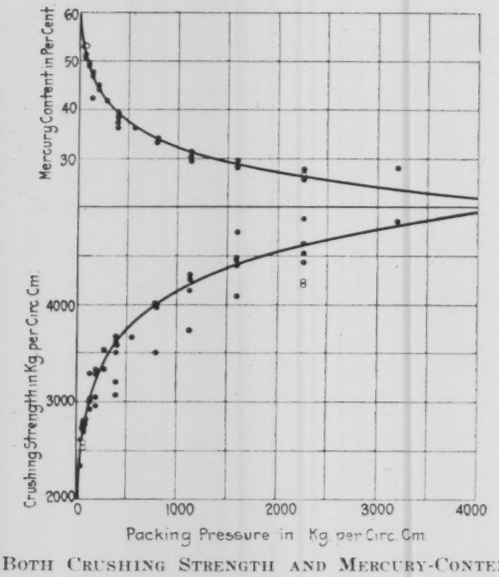


FIG. 2 BOTH CRUSHING STRENGTH AND MERCURY-CONTENT OF AN AMALGAM VARY AS LOGARITHM OF PACKING PRESSURE. LARGE DEVIATIONS FROM LOWER CURVE ARISE FROM CRUSHING SPECIMENS AT VARIOUS TEMPERATURES

Marine Engineering A1-19. The Propulsive Efficiency of Single-Screw Cargo Ships. A comparison of hulls of longitudinal coefficients of 0.74, 0.76, 0.78, 0.80 and 0.82 and of the same overall dimensions. The parallel middle body should be about one-third of the length as determined in a previous test, but in these tests the parallel portion of the ship was made longer. The model was tested by self-propulsion, using a floating form of dynamometer to get torque, while thrust was measured by a spring attached to the thrust bearing, and revolutions of the shaft were measured by suitable means. The model was also tested from the towing carriage. With speeds up to 7 knots there was little variation in power, but the resistance in the ships with the higher longitudinal coefficient the increase of power was much greater than the increase in displacement. This would not prevent the use of the ships with the longer parallel section where cargo capacity is important. The general conclusion of the experiments is that for a well-designed hull with a propeller running at about 90 r.p.m., a hull efficiency of 1.09, a propulsive efficiency of 0.65 may be expected from single-screw cargo ships. This paper was read at the General Meeting of the Society for Naval Architects and Marine Engineers, Nov. 13, 1919, by Commander William McEntee, Construction Corps, U. S. Navy, Washington, D. C.

Metallurgy and Metallography A20-19. Copper Content in Steel. A report is made from the Bureau of Ordnance of the Navy Department that the Metallurgical and Testing Division have made experiments on steel in which the copper content was increased to as much as 2 per cent. The gun factory has been manufacturing nickel steel with copper contents between 0.4 and 0.7 per cent, and when properly handled these steels showed a marked superiority for most purposes over steel free from copper. The gun factory has not found that steel containing appreciable amounts of copper when properly made is more red-short than steel of similar quality free from copper. With poorly made steel red-shortness may be found.

In successfully manufactured steel containing an appreciable amount of copper, precaution must be taken to prevent the copper from liquating or separating during solidification as the solubility of copper is not as great in ternary alloys as in the case of other alloying elements. The usual practice in the gun factory is to keep the manganese content of the steel slightly higher when the alloy carries an appreciable amount of copper. The higher manganese content tends to hold the copper in perfect alloy and prevent the tendency to red-shortness due to the presence of slightly excessive amounts of sulphur. Steel with 2 per cent copper shows most excellent physical properties when liquation was prevented by rapid solidification of the ingot through a low pouring temperature and by use of a very heavy chill. Report by Lieutenant-Commander A. G. Zimmermann, U. S. Navy. Address Rear Admiral Ralph Earle, Chief of Ordnance, U. S. Navy, Washington, D. C.

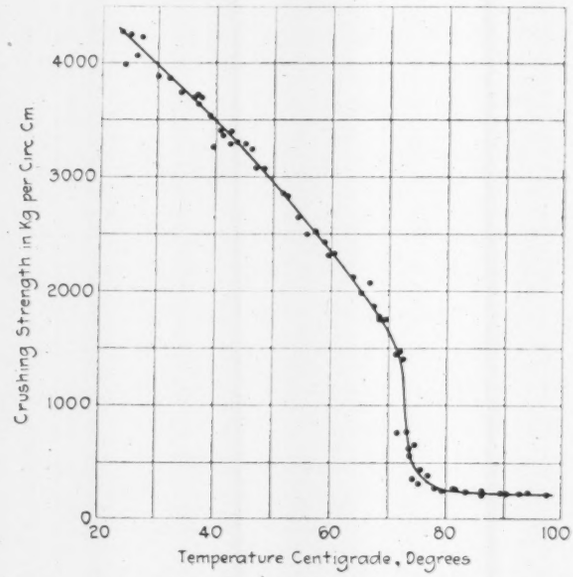


FIG. 3 EFFECT OF TEMPERATURE ON CRUSHING STRENGTH. TRANSITION REGION IS SHOWN BY THE RAPID FALL IN STRENGTH BETWEEN 70 DEG. AND 80 DEG.

Metallurgy and Metallography A21-19. Bronze. Effect of Boiling Bronze in Oil. The Bureau of Construction and Repair of the U. S. Navy reported that test bars of manganese bronze were being boiled in oil to improve the physical characteristics. This matter was investigated by the Metallurgical and Testing Division of the Ordnance Department of the U. S. Navy under the direction of Lieutenant-Commander A. G. Zimmermann. Although there was no reason to expect any decided change under these conditions four block test bars were taken and two specimens were machined from each block. One of each was boiled for one-half hour in sperm oil at a temperature of 150 deg. fahr. The physical qualities of the treated and untreated bars are given below to show that this treatment has no effect on the physical qualities of manganese bronze:

Not Treated.			Treated.		
Yield Point.	Tensile.	Elong.	Yield Point.	Tensile.	Elong.
46,100	76,400	21.75	50,400	76,400	22.00
42,900	75,200	25.50	47,900	74,900	25.50
44,400	77,400	23.25	43,900	75,600	23.50
49,400	79,500	18.75	47,900	79,800	16.50

Address Bureau of Ordnance, U. S. Navy, Rear-Admiral Ralph Earle, Washington, D. C.

Metallurgy and Metallography A22-19. Amalgams. The tests of dental amalgams formed by making an amalgam of mercury with an alloy of silver, tin and other metals has shown that the strength of the amalgam after hardening forms a logarithmic function of the pressure used in packing the amalgam and also the mercury content of this amalgam is a similar function. This is shown in Fig. 2.

The tests also show that there is a gain in strength due to the time of trituration, the maximum strength occurring at this time in six minutes. Temperature decreases the strength of an amalgam as shown in Fig. 3.

The amalgams change in volume during the time of hardening. This change in volume is called reaction expansion. They have been measured by a dilatometer capable of measuring to 1/500 micron. With heavy packing pressure the time to reach the maximum or minimum expansion is decreased. Increasing the trituration time accelerates the time of reaching the maximum pressure. Reducing the temperature retards the action. Time of packing does not have much effect. The amount of expansion is influenced by the time used in annealing the alloy for the amalgam. The greater the time of annealing the greater the reaction expansion. These results are of value to the mechanical engineer in that they are phenomena which occur in alloys not far removed from their melting points. These results are given in a paper by Arthur W. Gray, Ph.D., in the Transactions of the American Institute of Mining Engineers for December, 1918. Address Dr. Arthur W. Gray, L. D. Caulk Dental Company, Milford, Del.

Properties of Engineering Materials A7-19. Copper in Steel. See Metallurgy and Metallography A20-19.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Fuels, Gas, Tar and Coke B9-19. Gasoline from Heavier Oils. A series of experiments have been made by E. W. Dean at the Bureau of Mines Station, Pittsburgh, Pa., in which a study was made of the cracking reactions for conditions favorable for transformation of heavier oils into gasoline. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Fuels, Gas, Tar and Coke B10-19. Oil Shales. The Bureau of Mines is investigating the retorting of oil shales and the crude oils obtained therefrom. This work is under the direction of W. D. Bonner and M. J. Gavin, Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Lubricants B9-19. Analytical Distillation of Emulsified and High Boiling Oils by E. W. Dean, Pittsburgh, Pa. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Metallurgy and Metallography B16-19. Manganese Ores. The Bureau of Mines is investigating the mining and concentration of ores for the purpose of utilizing low-grade ores and the improvement of methods of mining. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Petroleum, Asphalt and Wood Products B1-19. Petroleum, Conservation and Production. The Bureau of Mines is conducting at its stations in Bartlesville, Okla, and San Francisco, investigations relating to petroleum conservation and production. The various headings are as follows:

Water Problems
Decline of Oil-Well Production
Oil Storage and Transportation Losses
Oil-Well Cements
Mode of Occurrence of Oil, Gas and Water in Underground Strata
Oil Casing, Perforation and Screen Pipes
Cement Oil Wells
Oil Camp Sanitation
Transporting Heavy Oils
Factors in Oil Production
Oil-Well Drilling on Government Lands
Transmission of Probable Depreciation
Methods of Increasing Production
Legislation
Construction and Operation of Oil Storage Facilities
Oil Shale
Circular Method of Oil-Well Drilling

Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Petroleum, Asphalt and Wood Products B2-19. Examination of American Crude Petroleum. A study of physical and chemical properties of American crude petroleums by (1) routing comparison of relatively large number of samples. (2) A detailed study of a smaller number of representative composite samples by E. W. Dean, Bureau of Mines Station, Pittsburgh, Pa. Address Bureau of Mines, Washington, D. C. Van H. Manning, Director.

Ventilation B1-19. Ventilation of Metal Mines. The Bureau of Mines is reporting through Daniel Harrington the investigations on the ventilation of the Butte mines. The report will discuss the underground and surface conditions affecting the flow of air and its adequate distribution. This will be discussed in its application to general principles. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Kansas State Agricultural College D2-19. Thermal Testing Plant. The refrigerating equipment: 2-ton experimental steam-driven refrigerating system of direct expansion, compression type and duplicate 1-ton electrically-driven system. Calorimeter room 9 ft. x 12 ft. x 10 ft., built of cork board and equipped with 600 ft. of 2-in. direct-expansion piping. The quantity of ammonia circulated together with temperature regulation is controlled through expansion valve and speed of compressor. Temperature regulated within ½ deg. fahr. Test boxes are cubes of 2 ft. in diameter. Three boxes are being used; one of 3-in. cork board, one of 3-in. waterproof lith board and one of 2-in. waterproof lith board. The boxes are heated electrically by special alloy resistance coils placed within each box. Three coils are used in each box. The current is supplied by 12-volt storage battery, being regulated by variable external resistance.

The temperature is measured by electric pyrometers accurate to 1/5 deg. fahr. These are thermocouples of No. 16 gage copper-constantan wire and are connected to the potentiometer indicator by a multiple switch. The cold end of the thermocouple is inserted in a vacuum bottle containing a liquid, the temperature of this liquid being measured by means of a mercury thermometer.

There is no fan within the test box. The heat through the top and bottom is figured separately from the heat through the sides by determining temperature difference of various surfaces.

It is hoped that investigations will throw light on heat transmission due to radiation as well as that due to convection. It is also planned to determine, if possible, the relation between temperatures at various points in the interior of the box and the heat transmitted per sq. ft. through the material.

Massachusetts Institute of Technology D1-19. Electrical Engineering Laboratory. The laboratories of the Department of Electrical Engineering of the Massachusetts Institute of Technology are four in number, their purposes and equipments being as follows:

The Electrical Measurements Laboratory is equipped for the general problems of electrical testing and electrical measurements including standardization. Insulating materials may be tested for dielectric strength of 100,000 volts and also special equipment for measuring losses of energy in dielectric when subject to alternating voltages.

The Dynamo Laboratory is equipped with instruments and apparatus necessary for problems relating to dynamos and special problems of losses in iron when subject to magnetization under various conditions of the form of test piece, the frequency of alternations of magnetism and variations of magnetic density.

The High-Frequency Laboratory is equipped with alternators giving alternating currents of 10,000 periods per second and 100,000 periods per second, also with kenetrons and other tuned devices for obtaining alternating currents of controllable frequencies and amounts. This laboratory offers excellent opportunity for studying special problems of radio telegraphy, and telephony as well as problems of skin effect in conductors when currents flow through them.

The General Research Laboratories are equipped with artificial lines representing certain conditions of very long-distance power-

transmission lines and of telegraph and telephone lines and some of the characteristics of real lines have been traced out. The equipment includes instruments for measuring tractive effort, for studies of motor transportation and street-railway transportation, hot-wire ammeters, sensitiveness of oscillographs and the characteristics of diaphragms.

The Department has published twenty bulletins after their publication as papers presented to the American Institute of Electrical Engineers, numbered as follows:

1 The Economical Transportation of Merchandise in Metropolitan Districts.
2 Notes on the Cost of Motor Trucking.
3 Observations on Horse and Motor Trucking.
4 Relative Fields of Horse, Electric and Gasoline Trucks.
5 The Delivery and Handling of Miscellaneous Freight at the Boston Freight Terminals.
6 The Delivery System of R. H. Macy and Co. of New York.
7 Explorations over the Vibrating Surfaces of Telephonic Diaphragms as Derived from their Motional-Impedance Circles.
8 The Mechanics of Telephone-Receiver Diaphragms as Derived from their Motional-Impedance Circles.
9 Experimental Researches on Skin Effect in Conductors.
10 Tractive Resistances to a Motor Delivery Wagon.
11 Some Properties of Vibrating Telephone Diaphragms.
12 Experimental Researches on the Skin Effect in Steel Rails.
13 Skin-Effect Resistance Measurements of Conductors at Radio-Frequencies up to 100,000 Cycles per second.
14 Street Railway Fares; their relation to length of haul and cost of service.
15 Apparent Dielectric Strength of Varnished Cambric.
16 Magnetic Flux Distribution in Annular Steel Laminæ.
17 Electromagnetic Theory of the Telephone Receiver with special references to Motional Impedance.
18 A Rectangular-Component Two-Dimensional Alternating Current Potentiometer.
19 Current Distribution in Armature Conductors.
20 Alternating-Current Planevector Potentiometer. Measurements at Telephonic Frequencies.

Mellon Institute D2-19. The Mellon Institute of Industrial Research is equipped for engineering research as well as that in pure and applied science. The following equipment is available for engineering work:

Two 100-hp. Sprague electric dynamometers equipped with revolution counters operated by the same electric circuit.

A three-section pipe arranged so that there is no end transmission of heat from the electric heaters on the inside of the middle section.

One standard Dodge automobile 4-cylinder gas engine connected to 75-hp. Sprague electric dynamometer equipped with automatic test timing device actuated by fuel-weighing scale.

Gas producer of modern mechanical type
Complete grinding and pulverizing machinery
Well-equipped machine and woodworking shop
Sweetland filter press
Vacuum dryer
Furnaces for refractory and ceramic research
Lummus column still.

Refrigeration D3-19. Thermal Testing Plant. See Kansas State College, D2-19.

E—Personal Notes

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

United States Naval Experiment Station E1-19. The work of the U. S. Naval Engineering Experiment Station at Annapolis, Md., consists of the following:

a Determination of conformity to specifications issued by the Bureau of Steam Engineering for particular materials or machines.

b Establishment of an "improved list" for the purchase of types and makes of materials and appliances coming under the cognizance of the Bureau of Steam Engineering.

c Determination of the most satisfactory of a number of devices as regards efficiency, performance, or other operative peculiarities.

d Obtaining data for the basis of specifications for the purchase of material or the modification of existing specifications.

e Furnishing the Bureau of Steam Engineering with design data and methods of design for various kinds of apparatus for which the existing data and methods are either insufficient or unsatisfactory.

f Investigation of new machines or materials and, if necessary, the development of them into practical form.

g Discovering the cause of failure or of poor performance in order to recommend to manufacturers and to the Bureau of Steam Engineering, alterations which will fit the apparatus or material under test for use in naval service.

h Regular courses of instruction to classes of student officers from the Post Graduate School, U. S. Naval Academy, and to undergraduate midshipmen from the U. S. Naval Academy.

There are three laboratories: the Engineering Laboratory, the Chemical Laboratory and the Metallographic Laboratory. In the Engineering Laboratory the following items are included:

Internal-combustion engines.
Refrigerating apparatus.
Condensers, air pumps, blowers, fans and air compressors.
Steam turbines.
Heaters for feedwater, fuel oil and lubricating oil.
Evaporators, distillers, pumps, rotary engines.
Safety valves.
Steam traps.
Pump valves.
Sheet and rod packings.
Boiler fittings.
Blow valves.
Water columns.
Gage glasses.
Feedwater regulators.
Stop and non-return valves.
Pump governors.
Pressure-regulating valves.

The work of the Chemical Laboratory is divided into several parts:

a All oils submitted for use in the naval service are tested in this laboratory and from the results of the tests recommendations are made to the Bureau of Steam Engineering for their approval or rejection.

b Analyses are made of boiler compounds, fuels, boiler deposits, boiler waters and all other materials as requested by the Bureau of Steam Engineering.

c New processes for production of hydrogen for aviation are proposed and developed.

d All problems in lubrication for the United States Navy are taken up in this laboratory.

e The chemical features of many problems connected with the operation and maintenance of naval machinery are investigated.

The work done in the Metallographic Laboratory consists of the following:

a Investigation of the cause of failure of metals in naval service, including shafting, boiler tubes, boiler plates, condenser tubes, gland rings, studs, metallic packing.

b Research with the view of determining the suitability of new alloys or new metallurgical methods for adoption in the Navy. These include bearing metals, aluminum alloys, nickel, silver and aluminum solders, welding methods, etc.

c Inspection tests, including metallographic inspection of forgings intended for naval service.

d Miscellaneous tests involving investigations for the preparation of specifications, standardization of tests, etc.

e Instruction of post-graduate students and undergraduate students of the Naval Academy.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Boilers and Accessories F3-19. Feedwater Evaporating Equipment. A bibliography of 1¼ pages. Search 2731. Address A.S.M.E., 29 West 39th St., New York.

Cement and Other Building Materials F1-19. Sand, Its Occurrence, Properties and Uses. A 72-page bibliography prepared by the Pittsburgh Carnegie Library. Price 15 cents. Address Director of the Carnegie Library, Pittsburgh, Pa.

Properties of Engineering Materials F2-19. Determining, Producing and Maintaining Hardness of Metals. A bibliography of 28 pages. Search 2683. Address A.S.M.E., 29 West 39th St., New York.

Properties of Engineering Materials F3-19. Design and Strength of Riveted Joints. A bibliography of 8 pages. Search 2740. Address A.S.M.E., 29 West 39th St., New York.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

STORAGE-BATTERY TESTING
CADMIUM ELECTRODES FOR STORAGE-BATTERY TESTING
BUREAU OF STANDARDS ANNUAL REPORT
BOND CLAYS AND GRAPHITE CRUCIBLES
FUEL-ECONOMY REPORT, BRITISH ASSOCIATION
GAS-SUPPLY STANDARDS
FUEL-OIL SITUATION IN EASTERN STATES
FLOW OF LIQUIDS, DETERMINATION OF VELOCITY
RIVA WATER TURBINES
WATER TURBINE WITH TWO WHEELS OF DIFFERENT DIAMETERS
VALVE DESIGN IN INTERNAL-COMBUSTION ENGINES
VALVE STEELS
HIGH-SPEED TURBINE GEARS
WIRE ROLLING-MILL GEAR DRIVE
LIMITS OF SIZE OF SINGLE-SHAFT STEAM TURBINES
DESIGN OF VERY LARGE STEAM-TURBINE UNITS
POWER PIPING
STANDARDIZATION IN POWER PIPING
MAXIMUM LENGTH OF LONGITUDINAL BOILER JOINTS
COXON AUTOMATIC STOP VALVES
LAP-SEAM BOILER EXPLOSION
PLACING A NEW TURBINE IN SERVICE
HORWICH SUPERHEATER FOR LOCOMOTIVES
QUINCY MARKET COLD-STORAGE PLANT AT BOSTON
COMPRESSOR FOR QUINCY MARKET COLD-STORAGE PLANT
INTERCOOLER OF COMPRESSOR FOR QUINCY MARKET COLD-STORAGE PLANT
THE MASS OF THE LITER OF AIR AND GAS MIXTURES
HEAT TRANSMISSION IN BOILER FLUES

BUREAU OF STANDARDS

STORAGE-BATTERY TESTING. In the operation and testing of storage cells, it is frequently important to know the individual potentials of the positive and negative plates. No standard method has been recognized. The results obtained with the cadmium electrode are often contradictory. This investigation has been made to determine the reliability of the cadmium electrode and the errors in measurement to which it is subject. The standard electrode used was the mercurous sulphate half-cell. It was found that the most serious error in using the cadmium electrode is due to polarization. By measuring the potential of the negative plate and computing the potential of the positive plate from this and the cell voltage, the most serious error of the cadmium electrode can be avoided, even when using an ordinary voltmeter. This investigation deals only with the accuracy of the cadmium electrode and does not discuss the cadmium readings with reference to the age or condition of the battery. (*Bureau of Standards Technologic Paper* No. 146, entitled The Cadmium Electrode for Storage Battery Testing, *g*).

Annual Report of Bureau of Standards

ANNUAL REPORT OF THE DIRECTOR OF THE BUREAU OF STANDARDS. A review of the work of the National Bureau of Standards for the year ended June 30, 1919, is given in the annual report of the Director of the Bureau of Standards at Washington. The report describes the functions of the Bureau of connection with standards and standardization, and contains a chart and description of the several classes of standards dealt with. The Director also gives a clear idea of the relation of the Bureau's work to the general public, to the industries, and to the Government, and includes a special statement of the military work of the year. Brief statements are made upon practically all of the special researches and lines of testing completed or under way at the Bureau. The list of these topics occupies 12 pages in the table of contents.

The Bureau is organized in 64 scientific and technical sections and 20 clerical, construction, and operative sections. During the year the Bureau has issued 51 publications, not including reprintings, 36 of which were new and 15 revisions of previous publications. In the several laboratories of the Bureau more than 131,000 tests were made during the year. The appropriations for the year, including special funds for war investigations, were approximately $3,000,000. A noteworthy event of the year included the completion of the industrial laboratory in which will be housed the divisions having to do with researches and tests of structural materials. The building also includes a commodious kiln house for use, among other purposes, of the ceramics division in the experimental production of new clay products and for general experimental purposes.

The report comprises 293 pages, and may be obtained as long as free copies are available by addressing the Bureau of Standards, Washington, D. C. (Abstract of *Miscellaneous Publication of the Bureau of Standards*, No. 40, *g*)

ENGINEERING MATERIALS (See also Internal-Combustion Engines)

THE PROPERTIES OF AMERICAN BOND CLAYS AND THEIR USE IN GRAPHITE CRUCIBLES AND GLASS POTS, A. V. Bleininger. The properties of American bond clays are described in detail and expressed through characteristic numerical values, with special reference to their burning behavior. It is shown that materials equal in quality to those formerly imported from Germany are available, and that by suitable blending any desired combination of properties can be readily produced. The characteristics of natural and artificial graphite are described and means suggested for the control of crucible mixtures. The fact is brought out that the main advantage in the use of German glass-pot clay consists in its low shrinkage, and suggestions are made for obtaining similar conditions with the use of domestic materials and with increased resistance to corrosion. The compositions and the preparation of semi-porcelain and porcelain glass pots are given. The method of casting glass pots as practiced at the Pittsburgh laboratory of the Bureau of Standards is also described. (Abstract of *Technical Paper* 144, *U. S. Bureau of Standards*, *g*)

FUELS AND FIRING

FUEL-ECONOMY REPORT OF THE BRITISH ASSOCIATION. The report consists of several parts. The first part outlines the work of the Committee since 1916. The second part deals with coal output and prices since 1913. The third part (on Coal Research) states that the recent experiments by Bone and Sarjant make it very doubtful whether the resinous and cellulose constituents of coal can really be separated by the aid of pyridine and chloroform. It would appear that pyridine affects the coal substance as a whole, especially at higher temperatures and pressures, while the presence of water and oxygen retards the action.

The last part of the report is devoted to the subject of future standards of public gas supply. The Committee believes that the consumer should be supplied with a suitable gas for lighting and heating, while the recovery of by-products should be secured in the general interest. It would not exclude the distribution of surplus of coke-oven gas through the pipe mains and the steaming of incandescent coke in continuous vertical-retort working; but it would not oblige a gas coke to convert all its coke into water gas. The Committee would not admit further that the relative value of a grade of gas was simply proportional to its calorific

value. The composition of the gas was not an indifferent matter to the consumer—in particular, the percentage of CH_4 should not be reduced below 30; also, to strip the gas of benzenoid hydrocarbons seemed inadvisable, if the thermal basis were to be adopted. (*Engineering*, vol. 108, no. 2809, Oct. 31, 1919, pp. 574-576, *g*)

FUEL-OIL SITUATION IN THE EAST. An editorial article in *Power* touches upon the important change in the fuel used in large power plants in the Eastern States which has been gradually taking place in the last few years. One after another important plants have displaced coal in favor of fuel oil. This has been natural for several reasons. In the first place, the coal market was anything but attractive to the buyer, both as regards prices and conditions of supply. Also fuel oil is a more convenient fuel to handle, increases boiler and fuel efficiency and greatly cuts labor costs and troubles. On the other hand, the editorial calls attention to the very important fact that there appears to be no certainty that oil will be available for long periods as it is available today, even though three- to five-year contracts are possible. (*Power*, vol. 50, no. 17, Oct. 21, 1919, published Dec. 1, 1919, pp. 623-624, *g*)

HYDRAULIC ENGINEERING

Photographic Method of Determining Velocity of Flow of Liquids

DETERMINATION OF VELOCITY OF FLOW OF LIQUIDS, C. Camichel. An article describing the method of determining the velocity of flow of liquid by the observation of the travel of very fine particles carried along by the liquid.

This method was employed for the first time by Scott Russell. The author, who is the director of the Electrotechnic Institute of Toulouse, France, indicates briefly some of the results which have been obtained by applying this method to various hydrodynamic problems.

I *Flow of Water between Two Vertical Parallel Plates, such as Glass.* The x axis is horizontal and parallel to the plates; the y axis is horizontal and normal to the plates; the velocity of

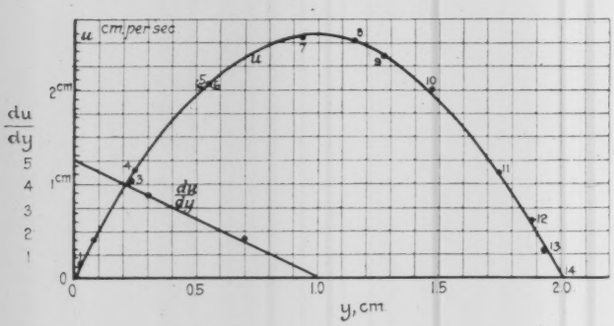


FIG. 1 CURVE DISTRIBUTION OF VELOCITIES IN FLOW OF WATER BETWEEN TWO PARALLEL PLATES

flow u satisfies the relation resulting from the equation of Navier

$$\mu \frac{d^2u}{dy^2} = \frac{dp}{dx} \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

where p_0 is the hydrostatic pressure; $p + p_0$ the pressure during the flow, p being a function of x only.

The following are some data obtained experimentally. The water flows between two parallel vertical glass plates located at a distance of 2 cm. from each other, the plates themselves being 30 cm. (11.8 in.) wide and 4 m. (13.1 ft.) long. The experiment consists in lighting up horizontally very fine particles suspended in the water by using a luminous batch of rays interrupted by a toothed wheel rotating at a constant speed, and in taking photographs by means of a camera placed at a point on the horizontal median plane.

A number of illustrations reproducing the photographs thus obtained are given in the original article, but they are not distinct enough for further reproduction. A very careful examination of these photographs shows that the reflection on the glass of the trajectories of the particles makes it possible to determine with considerable precision the values of y measured from one of these walls. Table 1 gives data obtained from one such test. It is easy to see that the curve (u, y) is a parabola and it is enough to plot a curve with ordinates du/dy and abscissæ y to see that such a curve is a straight line. This has been done in Fig. 1.

If we take as a coefficient of viscosity of the water $\mu = 0.011$ in C.G.S. units for the temperature prevailing during the experiment (16 deg. cent.), we get

$$\mu \frac{d^2u}{dy^2} = 0.0605 = \frac{dp}{dx}$$

The value of the loss of head W for two points located on a line parallel to the axis of x and at a distance of 80 cm. from each

FIG. 2 DISTRIBUTION OF VELOCITIES IN A GYRATORY MOVEMENT

other, we find to be $W = 0.05$ mm. Though it is difficult to find the correct value of such a small loss of head, it can be measured by means of the M. R. Threlfall manometer with a micrometric screw; this gives for W the value of 0.07 mm., which is in sufficiently good accord with the formula above.

The above experiment has been carried out with the velocity

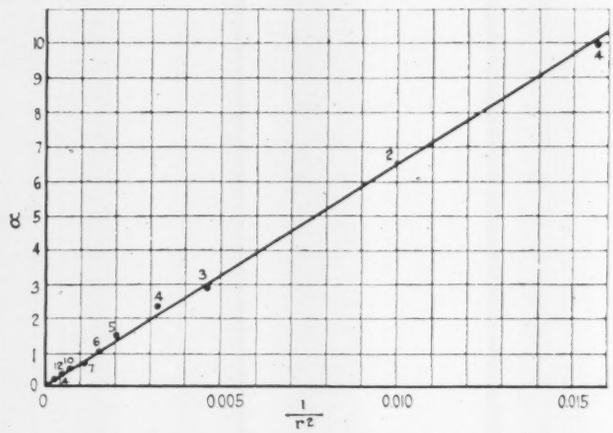


FIG. 3 DISTRIBUTION OF VELOCITIES IN A GYRATORY MOVEMENT

of flow of water reduced as far as possible, but similar experiments have been carried out for very much higher velocity.

II *Gyratory Movement about a Vertical Axis.* In studying rotary movements accompanying flow of liquids from orifices, Boussinesq has shown that if one limits himself to the consideration of the superficial particles of the liquid the velocity of flow is proportional to the distance r from the axis, in the part where the trajectories of flow are approximately horizontal, so that

$$ur = C \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

TABLE 1

No.	r cm.	u cm. per sec.	Remarks
1	0.026	0.15	The period of oscillations is 0.17 sec.
2	0.086	0.4	
3	0.23	1.03	
4	0.24	1.13	
5	0.53	2.02	
6	0.55	2.04	
7	0.94	2.54	
8	1.15	2.52	
9	1.27	2.34	
10	1.47	2.00	
11	1.75	1.11	
12	1.88	0.60	
13	1.94	0.3	

TABLE 2

No.	α	r mm.	$\frac{1}{r^2}$
1	99°	8	0.0166
2	65°	10	0.0100
3	30°	14.7	0.0046
4	23°3′	17.8	0.0032
5	14°7′	22.0	0.00207
6	10°5′	25.5	0.00154
7	8°0′	29.0	0.00119
10	4°9′	39.0	0.00066
12	3°0′	46.5	0.00046
14	2°2′	57.8	0.00030

TABLE 3

$z_0 - z$	$2r$	$\frac{1}{r^2}$
1	60 mm.	0.0011
2	29.7	0.0045
3	23.6	0.0072
4	20.2	0.0098
5	18.0	0.0123

FIG. 4 MERIDIAN OF GYRATORY MOVEMENT

This is roughly shown in Fig. 2 which demonstrates the distribution of velocities of flow in a gyratory movement about the vertical axis. Table 2 gives in numerical form the results of a similar experience; α designates the angle formed by the rays passing through two extreme positions of a particle at the beginning and end of a photographic exposure.

Fig. 3 represents the curve having for its abscissæ $1/r^2$ and for its ordinates α. It is a straight line. The angular velocity varies therefore inversely as the square of the distance of the particle from the axis, and hence the linear velocity varies inversely as the distance from the axis, in accordance with Formula [2]. If we apply the theory of Bernoulli and designate by h the depth $z_0 - z$ of the free surface below the horizontal plane containing the limit of the vortex of radius r_0, which is very large, we have approximately

$$h = \frac{C^2}{2g}\frac{1}{r^2} - \frac{1}{r_0^2} = \frac{C^2}{2g}\frac{1}{r^2} \quad \ldots\ldots\ldots\ldots\ldots [3]$$

The experiment consisted in photographing the meridian of the gyratory movement, that is, the curve having for its abscissæ r and for its ordinates h, Fig. 4, and also the distribution of velocities shown in the original article in a figure not suitable for reproduction.

In this experiment 100 mm. of the caliber occupied 108 mm. on the photographic plate, the periods of interruption of the ray of light being 0.026 sec. The meridian of the gyratory movement is given in Table 3 for points which are not too close to the axis. The curve with abscissæ $\frac{1}{r^2}$ and ordinates $z_0 - z$ is a straight line for points which are not very close to the axis, as shown in Fig 5. The angular coefficient of this straight line is

$$\frac{C^2}{2g} = 4.1 \times 10^{-3}$$

and the distribution of the velocities gives

$$\frac{C^2}{2g} = 4.2 \times 10^{-3}$$

a value in good accord with what has been given above.

In the preceding experiment the gyratory movement was counter-clockwise. There is, however, no difference between the clockwise and the counter-clockwise movements. It is intended to carry out an investigation of the distribution of velocities in the neighborhood of the axis and in the interior of the liquids. (*Revue Générale de L'Électricité*, vol. 6, no. 21, Nov. 22, 1919, pp. 707-709 and 2 plates, 8 figs., *etA*)

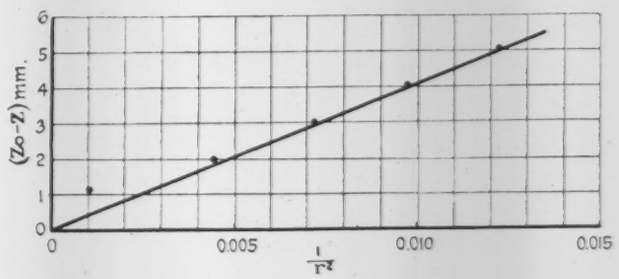


FIG. 5 MERIDIAN CURVE OF GYRATORY MOVEMENT

Water Turbine with Two Pelton Wheels of Different Diameters

ITALIAN WATER TURBINES, Norman Davey. First of a series of articles entitled Notes on a Tour in Italy and France, devoted chiefly to the description of hydraulic machinery.

In the Riva (Milan) type of larger turbines particular attention is called to the oil-pressure thrust block. The end thrust of the rotor is taken up by oil pressure upon the surface of a disk attached to the turbine shaft; oil under pressure is circulated on both sides of the disk and an equilibrium of thrust is thus secured.

Mention is made of a rather unusual type of turbine which the author has seen in the process of construction. It is to be used to produce power for the Italian Electric State Railways. The machine consists of two Pelton wheels of different diameters, employing varying heads of water, the water in question being drawn from two different sources of supply. Of the two wheels which are upon the same shaft, one is operated by a head of 2000 ft. and the other of 670 ft. As a large variation of load occurs throughout the 24 hr., the plant is fitted with an automatic device by means of which the smaller wheel, which is only used when the load rises to a certain point, may be put to work. The diameters of the two wheels taken at the centers of the buckets are 6.4 ft. and 3.67 ft., respectively, and the speed 500 r.p.m. The larger diameter wheel develops 3500 hp. with one jet and the smaller wheel 2500 hp. with two jets.

The machine is shown in Fig. 6 where the oil thrust block can

be seen beyond the bearing to the left of the larger-diameter wheel. The 6.4-ft. wheel has buckets 10 in. in diameter and the 3.67-ft. has buckets 13 in. in diameter.

An interesting feature of the Riva turbine of the Pelton type is the method of governing speed, or rather the control of the water jet. This is effected in two ways—first by deflection and next by throttling (Fig. 7). In it *A* is the lever working on a fixed fulcrum. To one end of this lever is attached a dashpot *D*; on the other end is fulcrumed the floating lever *B*. One end of this floating lever operates the deflector *C* and the other is connected with the governor. The fulcrum itself is connected with jet *K*.

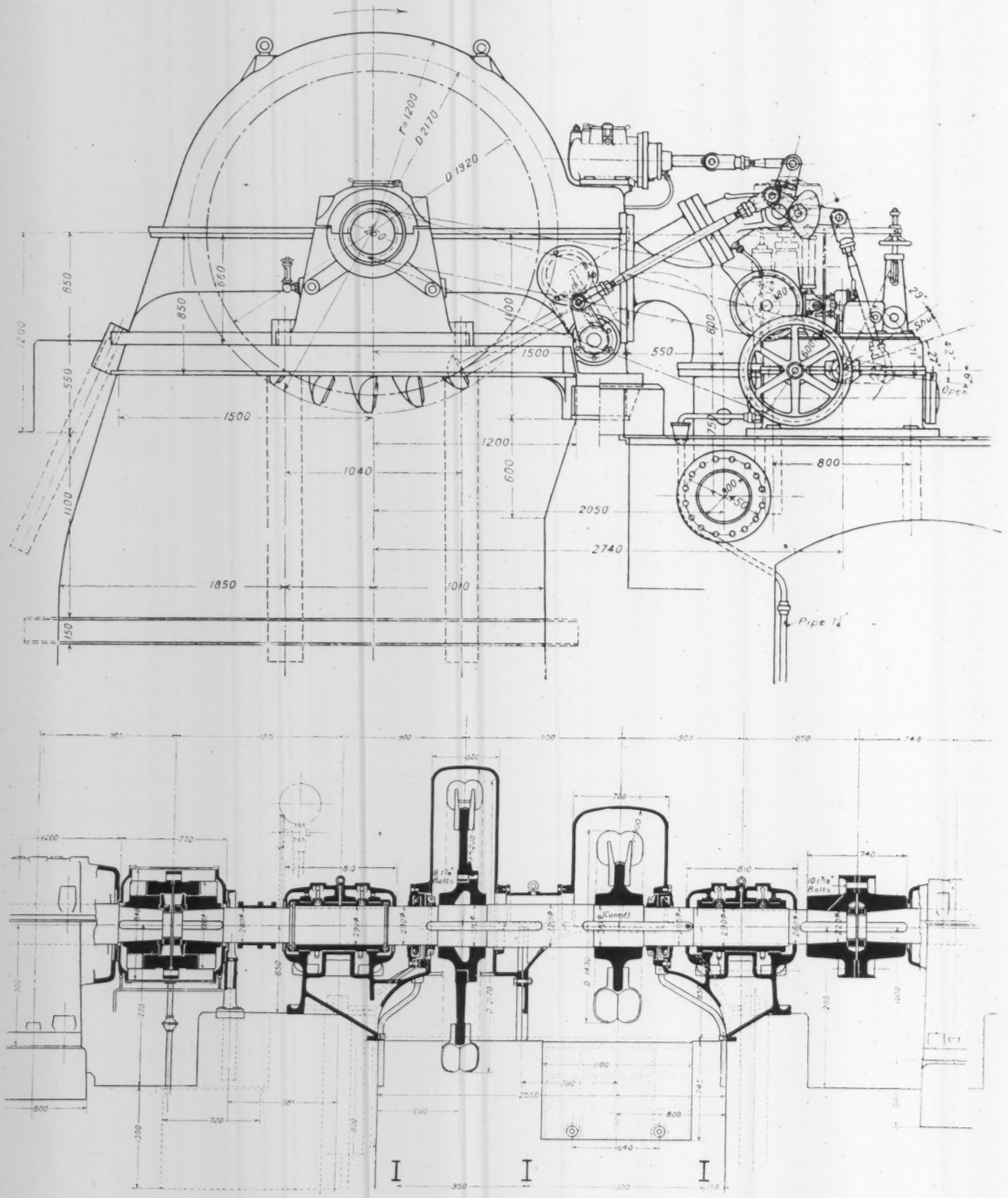


FIG. 6 DUPLEX PELTON WHEEL TURBINE FOR ITALIAN STATE RAILWAYS

Suppose the load to be suddenly removed from the turbine and racing to commence. The governor immediately reacts on the floating lever *B* and the deflector comes into action on the water stream. Since resistance is offered in this operation to the turn-

ing of the lever *B* about its fulcrum, the fulcrum itself becomes a moving point about the fulcrum of the lever *A* and the jet *K* begins to close. The arrangement is really an application of the floating lever principle as used in various differential gears to this particular purpose. (*The Engineer*, vol. 128, no. 3332, Nov. 7, 1919, pp. 456-457, 6 figs. in the text, *dA*)

INTERNAL-COMBUSTION ENGINES

Why Valves Fail in High-Speed Internal-Combustion Engines

VALVE FAILURES AND VALVE STEELS IN INTERNAL-COMBUSTION ENGINES, Leslie Aitchison. Discussion of the different troubles which arise with valves and steps which should be taken in order to overcome them in the most likely manner, as well as data of tests carried out by the writer, who, during the war, was acting as metallurgist at the British Air Board.

As regards the removal of heat from the inlet valves, it is pointed out that this is done in three ways: First, by conduction down the stem of the valve; second, by direct radiation from the back surface of the head or the neck of the valve; and third, by direct conduction from the face to the valve seat, the third method being the most important.

For proper cooling of the inlet valve two things are essential:

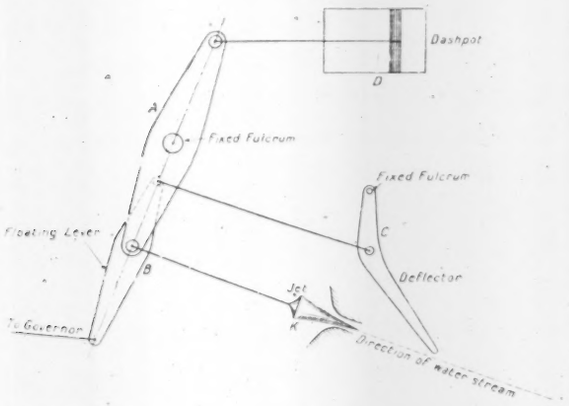


FIG. 7 RIVA SPEED-CONTROLLING ARRANGEMENT FOR PELTON WHEEL TURBINES

First, that the two surfaces shall come accurately together; and second, that the valve shall be closed at the moment of ignition, the second being the more important. The most prolific causes of troubles in valves are those produced by preignition in the cylinder. If the valve is not properly seated at the time of the explosion, there is a rush of hot gases around the valve, taking place at the time when the gases are near to their maximum temperature. The author has examined valves which failed in consequence of preignition and which must have been raised to a temperature of at least 1150 deg. cent. during the process.

Among the other factors which gave trouble is mentioned the work between the guides and the stem of the valves, which is of material importance in rotary engines.

The causes of failure of valves are classified and discussed. Only the most important will be mentioned here.

Distortion of the head of the valve may arise from various causes. In one engine it was traced to the fact that the stampings which were used had not been properly heat-treated, and the strains produced by the forging operation had not been removed. When the valve became heated in the running of the engine these strains were released and the valve warped appreciably, sufficiently so to prevent its seating properly. But distortion of the head of a valve may occur even with the proper heat treatment of the forging, and if the valve is so placed that the head is unequally heated this inequality of temperature may have a distorting effect. Distortion in the head of the valve may further be due to excessive softening of the steel during running, as a result of which the valve is pulled out of shape by hammering against the seat. The causes of the softening are twofold—either the employment of a steel which is not sufficiently strong at high temperatures, or else the utilization of a design in which there is not sufficient metal in the valve head.

Cracks in the valve face are a fairly prolific source of trouble. They are usually due to faults of metal, but from whatever cause they may come they are dangerous.

Excessive wear of the valve foot is usually found in valves in which a blow of the tappet is delivered directly on to the foot of the valve, or in which the cam acts directly on the valve stem, no cap being fitted to take the blows or the wipe. It is not always easy to provide the proper steel in the foot of the valve to take care of this condition.

Burning out of the head of the valve may be due to several causes which may not be entirely attributable to the steel. It is much more nearly true to say that in all cases where burning out occurs, the engine has been running badly. One of the principal causes is the oxidation or scaling of the steel. Cracks in the valve face are also a very prolific source of burning out. If the valve does not sit properly, burning out is almost always a result.

Breaking of the head or neck is due to self-hardening. Various cases have been known in which the valve has worked satisfactorily for a certain length of time and then failed by breaking up of the head or the snapping of the neck of the valve. This is found to happen most frequently when starting up an engine which has previously run and then gone cold. Also, the valve which most usually fails in this manner is the one which is manufactured from air-hardening nickel-chromium steel. The valves during the first running have been heated to a temperature greater than, say, 750 deg. cent. and then have been allowed to cool down. As a result of this cooling, the valves have hardened to such a degree that the maximum strength of the steel has reached a figure of possibly 100 tons per sq. in.

This hardening is generally accomplished by the production of a certain amount of brittleness. When the engine is restarted the brittle valve breaks in the head, or else the head falls right off. To obviate this trouble, it is essential that a steel should be chosen which does not harden when cooled in the air from the temperature obtained by the valve during the running of the engine into which it is put.

IDEAL VALVE STEEL

Steel which is to be used for the manufacture of gasoline-engine valves should possess certain properties and it is difficult to expect all these properties will be found in one and the same steel. These properties are:

1 The greatest possible strength at high temperatures
2 The highest possible notched-bar value
3 The capacity of being forged easily
4 The capacity of being manufactured free from cracks, whether these arise in the manufacture of the steel bar or whether they are produced during the forging of the steel.
5 The capacity of being heat-treated easily, regularly and reliably
6 The least possible tendency to scale, and if scaling does occur the scale should be as adherent as possible.
7 The reliability to retain its original physical properties after frequent heatings to high temperatures followed by cooling to normal temperature, also after being heated to an elevated temperature for a considerable length of time
8 No liability to harden when cooled in air from the temperature which it will retain when used normally as a valve in an engine
9 The capacity of being heat-treated after forging so that it is free from strains liable to produce distortion
10 Sufficient hardness to withstand excessive wear in the stem
11 The capacity of being hardened at the foot of the stem with considerable ease if necessary

12 The capacity of being machined easily and satisfactorily by ordinary methods.

It does not appear that there is a steel which would possess all of these properties. Table 4 shows the compositions of the various steels which have been used, and there does not seem to be any reason for using such a large variety. In order to evaluate the adaptability of various steels for use in valves, a large number of tests have been carried out, mainly at high temperatures. These tests have been tensile tests chiefly, supplemented by notched-bar tests at high temperatures, and, in some cases, Brinell hardness tests and observation for scaling.

In view of the importance of tungsten steel, Fig. 8 is here reproduced; likewise Fig. 9, showing the resistance to scaling of the various types of steel.

The tests have shown that the principal factor in deciding the properties of a steel at high temperature is its type. By this is meant that all the tungsten steels, for example, have fairly similar properties which make them, as a type, distinct from chromium steels or nickel-chromium steels.

There is a considerable similarity as regards mechanical properties at high temperatures between those steels which have a similar constituent.

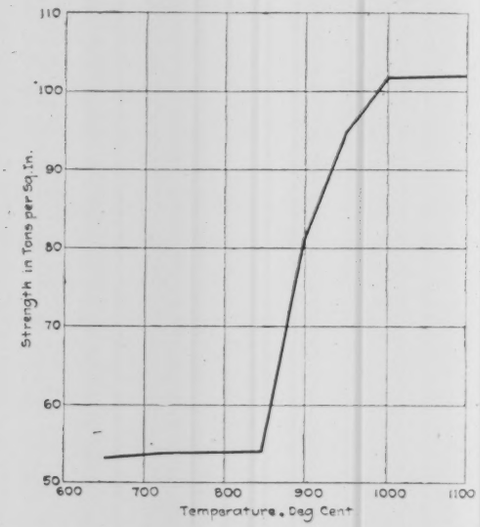


FIG. 8 STRENGTH OF TUNGSTEN VALVE STEELS AFTER COOLING FROM HIGH TEMPERATURES

Among the different steels in any type, variations in composition have a distinct effect upon the mechanical properties at high temperatures. This is particularly true of the high-tungsten and high-chromium steels in which variation in carbon content produces a very marked effect upon the tensile strength or the notched-bar value. This variation is also noticeable in the 3 per cent nickel and 3 per cent chromium steels that is not so marked as in the steels containing a larger proportion of alloying elements. In these steels a variation of 0.2 per cent of carbon will have a greater effect upon the strength than a variation of 5 per cent of tungsten and nearly 7 per cent of chromium.

Tungsten steels with high percentages of carbon (about 0.6 per cent) have the greatest tensile strength at high temperatures. This strength is nearly approached by that of the high-chromium steels containing a high percentage of carbon.

Steels containing a high percentage of chromium with a lower percentage of carbon (such as stainless steel) are distinctly weaker than either high-tungsten steels or the steels containing a similar proportion of chromium with high carbon.

Plain nickel or nickel-chromium steels are quite weak at high temperatures as compared with the other steels. Variations in composition among these steels have apparently very little effect. The influence of vanadium and cobalt appears to be negligible.

As regards scaling, tungsten steels scale comparatively little up to temperatures of about 850 deg. cent., but beyond that they are liable to scale very considerably. Nickel-chromium steels scale to a greater extent than do the steels of any of the other types, while the high-chromium steels present the greatest resistance to scaling at high temperatures of any of the steels.

TABLE 4

Steel	Carbon	Nickel	Chromium	Tungsten	Cobalt	Vanadium
a	0.65	.....	3.5	17.0	....	0.8
b	0.60	.....	3.5	14.0	....	0.8
c	0.25	.....	3.5	11.5	....	....
d	0.30	25.0	.....	....	....	....
e	0.35	.....	13.0	....	....	....
f	0.70	.....	11.0	....	....	....
g	0.80	.....	7.0	....	....	....
h	0.35	3.0	.....	....	....	....
j	0.60	3.0	.....	....	....	....
k	0.30	3.75	1.0	....	....	....
l	0.30	4.25	1.4	....	....	....
m	0.15	3.75	1.0	....	....	....
n	0.10	5.8	0.25	....	....	....
o	0.30	.....	.....	....	....	....
p	1.0	0.5	11.5	....	4.0	....

The general properties of valve steels in use are next discussed and interesting data are given as to their heat treatment.

The writer recommends the selection of steels from one of the three types: tungsten steel, high-chromium steel and nickel steel, eliminating entirely the nickel-chromium steels, and suggests the following allocation for the different steels:

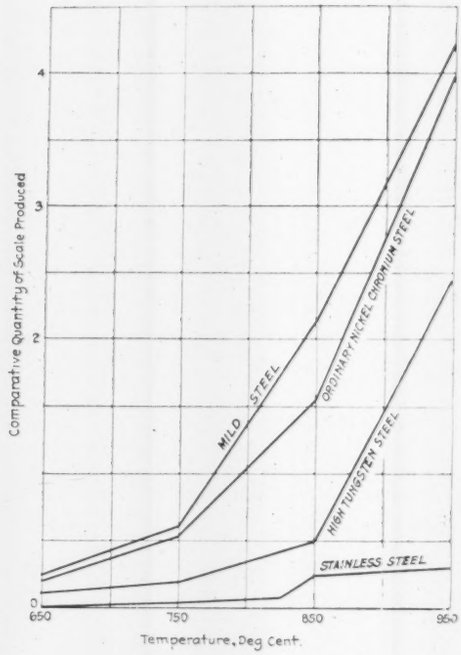


FIG. 9 COMPARATIVE CURVES OF RESISTANCE TO SCALING OF THE VARIOUS TYPES OF STEEL

All inlet valves.....3 per cent nickel steel
Exhaust valves with a working temperature not higher than 600 deg. cent.....3 per cent nickel steel
Exhaust valves with a working temperature between 600 deg. cent. and 760 deg. cent..... high-chromium steel
Exhaust valves with a working temperature greater than 760 deg. cent..... tungsten steel

The article contains data of numerous tests on heat treatments which cannot be abstracted for lack of space. (*The Automobile Engineer*, vol. 9, no. 132, Nov. 1919, pp. 401-410, 13 figs., *peA*)

MACHINE PARTS AND DESIGN (See also Internal-Combustion Engines)

Present Status of High-Speed Turbine Gearing

HIGH-SPEED TURBINE GEARS, Gerald Stoney. The paper starts with brief historical remarks on the use of high-speed gearing.

The present status of the matter is that gearing is used in all cases for large powers, except in the case of steam turbines driving alternators, where it is found that the satisfactory alternator can be made for speeds suitable for the steam turbine.

As regards types of gearing suitable with steam turbines, rope, chain and belt gearing are all impractical, and the only types used are hydraulic, electric and helical, only the latter being discussed here in detail. The helical gear, among other advantages,

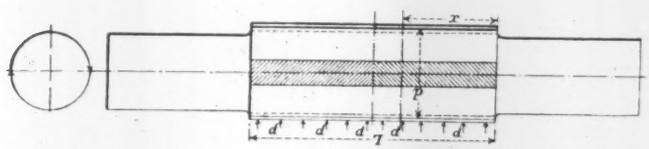


FIG. 10 DIAGRAM OF A PINION OF A HIGH-SPEED TURBINE GEAR WITH INDICATION OF STRESSES

possesses the highest efficiency, between 98 and 99 per cent, and is used especially in marine propulsion on an immense scale.

The design for helical gearing for use with steam turbines is discussed in brief. Tooth speeds up to 120 ft. per sec. are common and have, in many cases, been exceeded. What is exactly the limit of speed is uncertain, but so long as lubrication can be maintained there does not seem to be any reason why the figure given above should not be considerably exceeded. The load on the teeth is determined by the safe limit of bending stress on the tooth and of the pressures at the point of contact, as well as by danger of the oil-film failure. The bending stress can, in general, be ignored. As regards crushing stresses on the material of the tooth, the load per inch run will vary directly as the diameter, or $p = ad$, where p is the load per inch run in pounds, d the pitch diameter of the pinion in inches and a a constant. Similarly, the stresses of the oil film will obey some such law as $p = bd^n$. The theory of the lubrication of gear teeth is a most difficult one and is one that so far has been only partly worked out.

In England, Messrs. Parsons, who were the pioneers in these gears, resolved not to exceed $a = 80$ and $b = 175$, but as experience was gained b was increased first to 220 and now to 250.

The distortion of the pinion is next discussed. This is made up of two items—the twist of the pinion due to the torque it transmits, and the bending due to the load on the teeth. In estimating this it can be assumed that the load on the teeth is uniform along the pinion, and it may be further assumed that the effective diameter of the pinion is the pitch diameter.

At any point x in Fig. 10, the torque T is:

$$T_x = \frac{pxd}{2} = \frac{2fI}{d} = \frac{\pi f d^3}{16}$$

where f is the shear stress at the circumference of the pinion and I is the polar moment of inertia, or $\frac{\pi d^4}{32}$. Hence it follows that $f = \frac{8px}{\pi d^2}$. If N is the modulus of rigidity, which for steel is 12,000,000 lb. per sq. in.,

$$\frac{dv}{dx} = \frac{f}{N} = \frac{dx}{\pi N d^2}$$

$$v = \frac{4p}{\pi N}\,\frac{x^2}{d}$$

which is a parabola. The twist in the first half of the pinion is:

$$y_1 = \frac{p}{\pi N}\,\frac{l^2}{d}$$

and the second half:

$$y_2 = \frac{3p}{\pi N}\,\frac{l^2}{d}$$

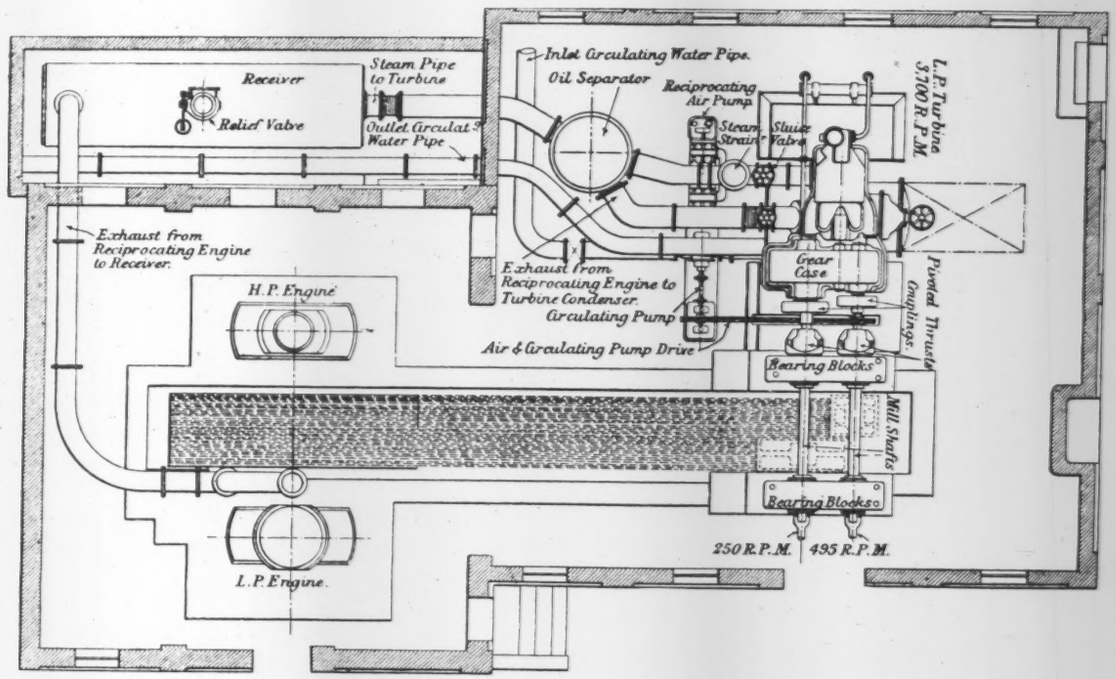


FIG. 11 COMBINATION OF GEAR TURBINE WITH A RECIPROCATING ENGINE FOR DRIVING A WIRE ROLLING MILL

The alignment of the gears in the gear case is of the greatest importance, as also is the construction of the gear case. In this connection the author discusses the rigid gear-case construction originally introduced by Sir Charles Parsons and the floating-frame type introduced by John H. McAlpine in America.

Several applications of gearing are described and illustrated, such as, for example, a geared turbine driving a cotton mill, and the combination of a geared turbine with a reciprocating engine for driving a wire rolling mill having two shafts running at different speeds (Fig. 11). The compound reciprocating engine runs at

80 r.p.m. and is supplied with saturated steam at 160 lb. pressure, originally exhausting into a central condenser at about 14 in. vacuum giving 2100 hp. By allowing it to exhaust at 16 lb. abs. and leading the steam into a turbine, exhausting into a condenser with 28.8 in. vacuum (barometer 30 in.), the engine gave 1650 i.hp., and the turbine 1663 i.hp., or a total of 3313 i.hp., an increase of 58 per cent in power with no increase in steam used, giving an increased economy of 36.6 per cent. The exhaust turbine runs at 3700 r.p.m., and the geared shafts at 500 r.p.m. and 250 r.p.m. The difficulty of the uneven turning moment of the reciprocating engine and the even turning moment of the steam turbine straining the gear is met by the flexibility of the rope drive. For starting up, the reciprocating engine can be exhausted to atmosphere.

It may be noted that if the power supplied to each low-speed shaft is equal, there will be no bending of the pinion, and the only distortion will be that due to twist. (Paper before the Manchester Association of Engineers, Nov. 22, 1919, reprinted in *Engineering*, vol. 108, Nov. 28, 1919, pp. 729-733, 14 figs., *dg*)

POWER PLANTS

How Large Can Steam Turbines and Turbo-Generators Be Made Today?

PRESENT LIMITS OF SPEED AND POWER OF SINGLE-SHAFT STEAM TURBINES AND TURBO-GENERATORS. A symposium of three papers. The first, by Eskil Berg, starts by showing that the limit of a single-unit turbo-generator does not lie in the generator, but is confined to the steam turbine, and that the limiting feature of the latter is the last wheel. The paper is based mainly on the work done by the General Electric Company.

Questions of design of the large turbines and of the conditions limiting the size are discussed.

Efficient action of the blades in large-size turbines operating with high vacuum can be accomplished only by using the bucket speed that bears a proper relation to the steam velocity, which means that to get the largest capacity not only long buckets must be used, but they must be moved at a very high speed. On the other hand, to obtain good bucket action the buckets should not be more than about one-quarter as long as the pitch diameter of the wheel.

The use of a high steam speed in the last stage naturally implies that a relatively large proportion of the total steam energy must be utilized there, and such concentration of work into a single stage has its disadvantages, even if the best relations of velocities is maintained.

Since such a stage is doing a large amount of work, it is naturally less efficient than a stage of similar character doing less work.

In this way the last wheel of the turbine becomes one of the limiting features of the overall dimensions. Energy and efficiency curves (Fig. 12) of the last stage are given which show that at the most efficient point this stage absorbs 11.5 per cent of the total adiabatic available energy, and that the wheel efficiency is 66.25 per cent. But this is for an output of 21,000 kw., and in the same turbine when the load increases to 36,000 kw. the energy in the last stage is 20.9 per cent of the total energy and the wheel efficiency goes down to 54.2 per cent.

The conclusion which the author comes to is that for a given speed there is one particular size of turbine which can be designed to be most economical as to steam consumption, weight, space and price per kilowatt. Even if a size smaller than this is required, it would, in many instances, pay for the central station to install a larger unit, even though it would have to run at reduced load for some time before the station load increased sufficiently to utilize its full capacity. (*Proceedings of the American Institute of Electrical Engineers*, vol. 38, no. 11, Nov. 1919, pp. 1223-1231, 6 figs., *g*)

In the second paper, F. D. Newbury discusses the conditions determining the size of a turbine and conditions limiting it.

In the opinion of the writer, maximum output at any speed when reduced to the simplest terms is attained when slot space is provided for the maximum possible ampere-turns (in either stator or rotor), and core cross-section is provided for the maximum possible flux. These conditions require the most effective rotor diameter and the maximum rotor and stator core length.

The most effective rotor diameter for a given speed is not necessarily the largest diameter, and to obtain maximum output at a given speed the rotor proportions must be chosen properly to balance mechanical stresses, rotor ampere-turns and flux.

The electrical factors in generator design are discussed by the writer, who believes, among other things, that a fundamental difficulty in setting down definite limiting outputs is the difficulty in arbitrarily setting limiting stresses.

On the other hand, limit of length of the rotor and stator cores is determined mainly by such considerations as cooling-air requirements, bearing proportions, by limits to weight imposed by transportation facilities and the ability to secure forgings of necessary diameter and weight.

To give an idea of the character of these limitations, it may be stated that, for example, transportation facilities may impose a limit to size in the case of 6- and 8-pole 60-cycle generators. From the special nature of their design and the special skill and equipment required for winding and assembling, rotors should be completed at the builder's factory and shipped as a unit. The

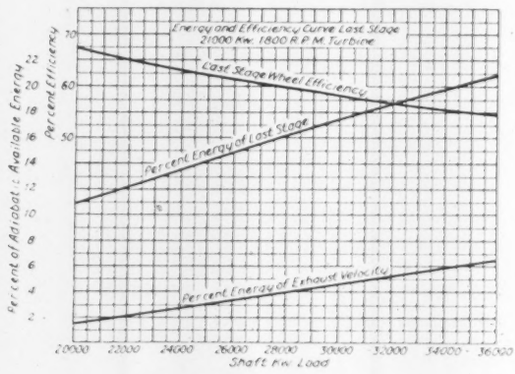


FIG. 12 ENERGY AND EFFICIENCY CURVES (LAST STAGE) OF A LARGE TURBINE

weight of the complete rotor of a 4-pole 1800-r.p.m. generator of 40,000-kva. capacity will be roughly 90,000 lb. This can be transported without difficulty, but the largest possible 12,000-r.p.m. rotor would weigh more than 200,000 lb. and would require rolling stock and trackage in some cases not now available.

Another general limitation to output of larger-diameter rotors is that imposed by the forging facilities of the country. At the present time it is not possible to obtain forgings of suitable physical characteristics weighing more than 50 or 60 tons nor much larger than 50 in. This limits the rotor made from a single forging to an output of, roughly, 50,000 kva. at 1500 r.p.m. By adopting the rotor construction involving 2-in. or 3-in. plates and upset flanged shaft ends, the limiting diameter may be increased sufficiently for the largest 1500- and 1200-r.p.m. outputs shown in Fig. 13.

This figure shows in curve form limiting generator capacities at various speeds. At 1500 r.p.m. and higher the capacity is determined by the rotor and is inversely proportional to the r.p.m. squared. At lower speeds the capacity is limited by the stator and falls somewhat below the corresponding rotor limiting capacity, as indicated by the dotted extension of the rotor curve. The curve is an indication of the present boundaries based on existing commercial materials and current stresses and bearing proportions. In fact, the capacities shown by it are somewhat in advance of accomplished results.

The writer claims that mechanical forces due to short-circuit and damage caused by armature-winding failures are no greater in the very large generators, indicated by the above figure, than the present-day 20,000- and 30,000-kva. unit.

No opinion is expressed as to the wisdom of installing very large single-shaft units. If operating engineers desire units of 50,000 to 100,000 kva., there is no question but that such generators can be conservatively designed and constructed. *Proceedings of the American Institute of Electrical Engineers*, vol. 38, no. 11, Nov. 1919, pp. 1233-1242, *g*)

The paper by J. F. Johnson is restricted to a discussion of some of the factors which influence limits as applying particularly to turbines of the reactionary type. The author expresses the opinion that with the employment of high vacua the limit of power is determined largely by the area obtainable through the last stage, for the final expansion and passage of the steam prior to its entering the condenser.

The significance of this is shown by the fact that whereas a pound of steam when entering the first stage has a volume of less than 2½ cu. ft., when passing through the last stage it has a volume of approximately 395 cu. ft. if expanded to 28.5 in. vacuum, and 585 cu. ft. if expanded to 29 in., the ratio in the latter case being 1 to 234.

Because of this, in any discussion of limits of power it is necessary to assume conditions of pressure and superheat of the steam entering the turbine, the vacuum to which the steam is to be expanded in the blading and the efficiency of change of steam flow per unit of power.

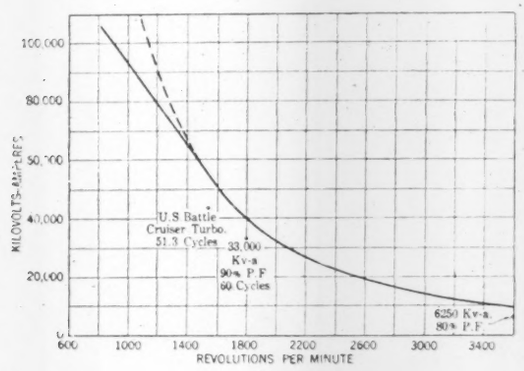


FIG. 13 LIMITING GENERATING CAPACITIES IN LARGE UNITS AT VARIOUS SPEEDS.

The limiting factors are divided into three classes by the author: (1) Theoretical, including limiting steam velocities and effect on efficiency of velocity remaining in steam after leaving the last stage, and the area through the blades as affected by blade angle; (2) Physical, including methods of construction, materials, stresses, factor and safety against rupture, reliability factor, and limitations of transportation facilities; (3) Economical, including limits beyond which it may be physically possible but economically inadvisable to go, such as effect of size of structure or of character of materials employed on costs and time required to make inspection and repairs. The paper is largely based on the practice of the Westinghouse Company.

As regards theoretical limits with materials of infinite strength and rigidity, it would have been possible to build units of infinite capacity, but for a given diameter and blade height the capacity is limited by chosen maximum values of steam speed through the blades, in order to keep the energy available in the steam discharged to the condenser within permissible limits.

Throughout the entire turbine, with the exception of the last few stages, steam speeds only about 25 per cent in excess of the corresponding blade speeds are employed in order to secure maximum efficiency. In the latter stages, however, the volumes become so great that steam speeds are increased sometimes approximately 100 per cent in excess of the blade speed, in order to effect a compromise between maximum theoretical efficiency and physical dimensions.

The question of blade angle is discussed next.

As regards the physical limits, the chief ones limiting turbine capacity are the physical characteristics of the material employed and the chosen limits to which these materials may be safely stressed.

Of course, the design of the rotor materially affects the stresses involved, but if the rotor design can be so modified as always to keep the stresses within necessary limits, then the stresses at the base of the limits or in blade fastenings determine the maximum capacity obtainable with a given speed.

There exist two interesting relations between the stress at the base of blades, steam-passage area through the blades, and rotative speed. For any given rotative speed and blade angle the steam capacity or steam area through the blades is directly proportional to the stress at the base of the blades, regardless of the diameter and blade height selected. This stress can only be modified by unevenly varying the cross-sectional area of the blades, such, for example, as thickening the blade near the base. Also for any given stress the area through the blades will vary inversely as the square of the speed, i.e., if at a speed of 1800 r.p.m. a given stress and area are obtained, then at 900 r.p.m. the area will be increased four times if the stress is kept constant.

In other words, as the writer shows in the original article, the area and stress are each equal to a constant times the product of mean diameter and blade height, and when the stress is constant this product varies inversely as the square of the revolutions per minute. The ratio of blade height to rotor diameter is therefore not a factor in determining physical limit of capacity, but only in determining efficiency cost and, to some extent, reliability of the turbine.

Increased capacity without decrease of rotative speed or increase in stresses may be obtained by employing multiple low-pressure stages, and the author gives a curve showing the limits of capacity of steam turbine with double-flow low-pressure stages.

In discussing the economic limits of turbines of large capacity, consideration is given to the fact that as yet such units are not required in sufficient quantity to warrant equipping and operating shops for their exclusive manufacture, and that they must be produced largely by the same processes and equipment as are used for smaller sizes which are built in greater quantities.

As the sizes become larger, a greater proportion of special equipment and processes becomes necessary, resulting in increased rates of cost unless accompanied by very material increase in production of quantity. Under present conditions this economic limit of capacity agrees closely with the physical limit of 1500-r.p.m. units.

Another factor tending to limit capacity of single units is the generating capacity loss resulting from suspension of service for inspection or repairs. For example, if a 30,000-kw. unit must be kept out of service ten days for a certain inspection or repair, a 60,000-kw. unit would have to be kept out probably fourteen days for a similar purpose because of the greater time required to handle the larger structure. Therefore, if two 30,000-kw. units were used and each held out of service ten days, the outage loss would be only five-sevenths as great as if a single 60,000-kw. unit were kept out fourteen days. (*Proceedings of the American Institute of Electrical Engineers*, vol. 38, no. 11, Nov. 1919, pp. 1243-1253, 6 figs., *g*)

Standardization in Power Piping

POWER PIPING, J. Roy Tanner and Geo. J. Stuart. A paper discussing the subjects of piping systems, their design, selection of materials, and details of construction.

The steam pressures carried have gradually increased until the present extra heavy material used for high-pressure steam is designed for 250 lb. working pressure, and the tendency is still upward. Material designed for 350 lb. and superheat is actually in use but has not yet had wide enough application to be reduced to standard practice.

The steam turbine has changed practice by bringing superheated steam from occasional into extensive use. This made it necessary to find substitutes for cast iron and bronze in fittings.

The former was replaced by cast steel and the latter, to a great extent, by Monel metal.

The importance of standardization as a factor in the industrial position of this country today is nowhere better illustrated than in this industry under discussion. A few years ago each manufacturer had his own standard for the dimensions of flanges, fittings, and drilling templets. This compelled the large users of piping, such as steel mills, to adopt something which was very likely to be original. Also, about the first thing an engineer did after putting up his sign, was to calculate and design his own piping standard. There was a tremendous amount of brain power consumed which can now be diverted to other purposes. The effect of this confusion was that manufacturing in all that the word implies was impossible because changes of flange sizes or center to face had to be made at frequent intervals. This condition prevailed long after The American Society of Mechanical Engineers, in 1894, adopted, after conferring with the Master Steam and Hot-Water Fitters and some of the manufacturers, a standard flange templet which subsequently became the "A. S. M. E. Standard" used for lower pressures, along with the "Manufacturers' Standard" for extra heavy material, in 1901, and it was several years after this before the flange situation became clarified.

Some time after 1910 a group of manufacturers of valves and fittings formed an organization called the Committee of Manufacturers on Standardization of Valves and Fittings, and began the work of designing a completely standardized line of fittings, including center to face, and shell thickness. This work was completed and published and about a year later revised to meet the views of The American Society of Mechanical Engineers regarding the bolting of extra heavy flanges larger than 12 in. This revision was accepted at a conference in Washington by representatives of the United States Government. The American Society of Mechanical Engineers, the Master Steam and Hot-Water Fitters, and the Manufacturers' Committee. The American Society of Mechanical Engineers adopted the report of its Committee—compiled under the direction of the late Mr. H. G. Stott—and thus made effective the American Standard for Pipe Flanges, Fittings and Their Bolting, to become effective January 1, 1914. The report of this Committee was a masterpiece of complete analysis.

The American Standard consisted of specifications for "Standard" material up to 125 lb. pressure and "Extra Heavy" material up to 250 lb. pressure.

The American Society of Mechanical Engineers and the Manufacturers subsequently collaborated in standardizing hydraulic flanges up to 3000 lb. pressure, culminating in the adoption of a report in December, 1918.

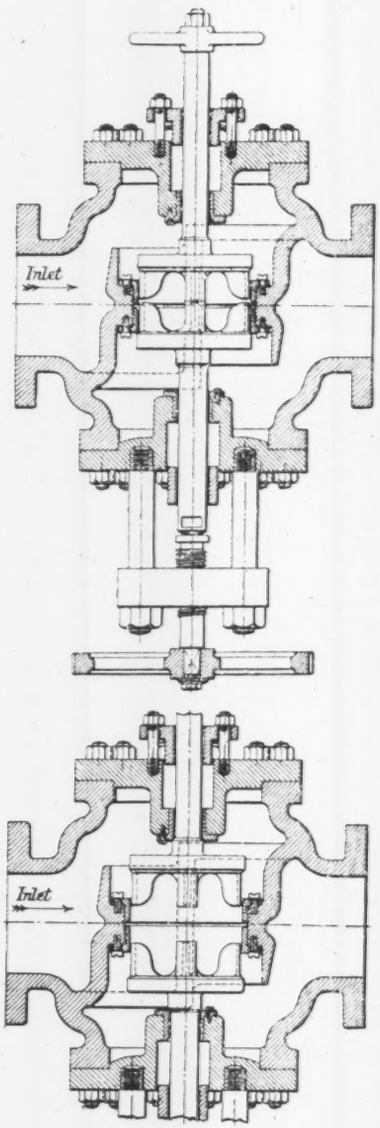
Economy demanded the use of a lighter design than that specified for 125 lb., for use on low-pressure water, condenser service, etc., and The American Society of Mechanical Engineers has made a recommendation for lighter shells and smaller bolts than the American 125-lb. standard, and flanges of the same diameter, thickness, and bolt spacing. The Manufacturers' Committee, however, is considering the advisability of using a thinner flange for this service, owing to the foundry difficulties attending such a great change in section, and may request The American Society of Mechanical Engineers to reconsider this point.

Some work had been done by the Manufacturers' Committee to determine the feasibility of standardizing valve dimensions from center to face, but with no results. In the fall of 1918, when the Emergency Fleet Corporation was struggling with the problem of a design for the piping of fabricated ships, the standardizing engineer for the Emergency Fleet Corporation, Mr. John A. Stevens, who played a large part in formulating the Boiler Code of The American Society of Mechanical Engineers, attacked the problem of interchangeable dimensions for the valves to be used by the fleet, calling to Philadelphia engineering representatives of all the large valve manufacturers and, had it not been for the armistice, the fleet would probably by now have had a standard center-to-face dimension for every valve to be used by them on shipboard. It is therefore not impossible that at some future date we may even have interchangeable face-to-face dimensions of valves.

A large amount of standardization work has been done by the Power Piping Society, an organization of fabricators and erectors. The "Standard Specifications for Power Piping" adopted by the society in 1915 was the result of the experiences of a group of men who had installed a considerable part of the power piping in this country, and can therefore be accepted as safe modern practice.

Thus out of chaos has come some degree of order, for the benefit of the use of pipe, valves, and fittings. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 35, no. 7, Oct. 1919, pp. 311-332 [original paper] and 333-347 [discussion], *g*)

COXON AUTOMATIC STOP VALVES. Description of a series of devices of British manufacture designed to automatically shut off steam in the event of a burst in the steam main or a similar accident to the apparatus to which it is supplied. The valves described and illustrated comprise a boiler junction valve, a combination safety valve and stop valve and an insulating valve for steam headers. This latter is shown in Figs. 14 and 15. The casing contains two similar valves, closing in opposite directions. The lower one is forced to its seat by means of the hand wheel and screw, and acts as an ordinary stop valve when closed in this



FIGS. 14 AND 15 COXON AUTOMATIC INSULATING VALVE FOR STEAM HEADERS

way. The valve spindle, however, is separate from the screw, and the valve can thus close independently of the hand wheel. The upper valve has no screw, and the spindle slides freely in its gland. When in use, both valves are normally held open by the steam pressure, but should the main burst on either side, the corresponding valve closes automatically and prevents steam flowing to the burst part. No by-pass is required to open the valve, because when the lower valve is shut it lifts the upper automatic valve slightly from its seat. When steam is admitted to the main, the upper valve also opens as soon as permitted by the operation of the hand wheel.

A feature of the valves described is that they have no springs and are so arranged that they can be readily tested at any time. (*Engineering*, vol. 108, no. 2809, Oct. 31, 1919, pp. 581-582, 9 figs., *d*)

WHAT SHOULD BE THE MAXIMUM LENGTH OF A LONGITUDINAL JOINT, C. E. Stromeyer. Attention is called to this article, the author of which is Chief Engineer of the Manchester Steam Users' Association for the Prevention of Boiler Explosions, and to an editorial on p. 624 of the same issue of *Power*. The article and the editorial are here abstracted together.

The writer of the article draws attention to the differences of engineering views on the two sides of the Atlantic. He claims that in England boilers have been made so safe that fatal boiler explosions rarely reach a dozen per year. He was shocked when on a recent occasion he heard an address by an American engineer who claimed to be qualified to speak about the practical working of boilers because he had been present at a dozen boiler explosions. Such an exciting experience is quite impossible in England.

The writer thinks, however, that there must be other causes than the use of long longitudinal seams to account for these numerous explosions and if these other causes be removed the question of length of joints will sink into insignificance.

The writer employed special strain indicators to measure the strains in the solid plates of boilers on either end of lap joints and also in the solid plates above and below the single-butt-strap joint of the hulls of iron ships, which construction was customary some thirty years ago. His observations showed that the strains in the solid plates close to the ends of lap joints were eight times greater than those in the solid plates away from the joints. Assuming that these joints had only 70 per cent of the strength of the solid plates, it is evident that the plates that adjoin lap joints are stressed about five times more severely than the joints themselves. These observations had been confirmed by unpublished experiments made in 1874 by the Manchester Steam Users' Association on a full-sized boiler whose solid plates ruptured under hydraulic pressure when the seams gave way.

The conclusion that is to be drawn from these two sets of experiments is that the breaking of joints is a source of weakness, that the longer we make the longitudinal joint for boilers the better. The author qualifies this statement, however, saying that it is intended to apply only to steels made by the acid open-hearth process. The Manchester Steam Users' Association refuses to sanction the use of basic steel in boilers.

As regards the experience of the Manchester Steam Users' Association, it is stated that since its foundation in 1854 it has issued over half a million certificates of safety and up to the time of the war it had had no accident entailing loss of life.

The editorial commenting on this article, asks:

"Why the Massachusetts Boiler Board considers both lap and strap joints dangerous in lengths exceeding 12 ft., while the Boiler Code Committee of the A. S. M. E. is apprehensive for lap joints only?

"Why the Board of Boiler Rules prohibits these joints on horizontal return-tubular, vertical-tubular, or locomotive-type boilers, and the A. S. M. E. only on horizontal return-tubular boiler?

"If they are dangerous in the shell of a locomotive-type boiler, why they are not equally dangerous in the drums of water-tube boilers?"

The editorial in *Power* also calls attention to the fact that both the Massachusetts Board and the A. S. M. E. Committee agree that the long joint is bad and should be avoided, while Mr. Stromeyer asserts that he is strongly in favor of long seams and prefers them to short ones, even if the plates are rolled parallel to the seams. (*Power*, vol. 50, no. 17, Oct. 21, 1919, published Dec. 1, 1919, pp. 626-627 (original article), and 624 (editorial comment) *gpA*)

EXPLOSION OF LAP-SEAM BOILER. Description of the explosion of a boiler as the result of a lap-seam crack which occurred at the boiler plant of the Sisters of St. Francis of Assisi at St. Francis, Wis. The boiler was 60 in. in diameter, 40 ft. long, and constructed of $\frac{3}{8}$-in. plate of flange steel and was built in 1904. There were two sheets of the shell plates, each sheet forming a complete ring with the longitudinal seam in the usual place, above the water line.

The longitudinal seams were of the double-riveted lap-joint type, there being two rows of $\frac{7}{8}$-in. rivets driven in 15 16-in. holes, with a rivet spacing of $3\frac{1}{4}$ in. The spring-loaded safety valve was set to blow at 95 lb. pressure. Information available shows that the boiler was clean and had received good attention in other ways. After the accident the safety valve was found to be perfectly free and unobstructed.

Examination of the exploded boiler developed the fact that the front course of the shell plate had failed from the head seam to the girth seam, a distance of 6 ft. 9 in. along the rivet holes of the double-riveted lap seam. The crack probably started at a point about 5 ft. from the front head where the plate was not homogeneous and gradually extended to the front-head seam, working deeper into the sheet until separation occurred. (*Power*, vol. 50, no. 17, Oct. 21, 1919 [published Dec. 1], pp. 604-605, 2 figs., *d*)

PLACING A NEW TURBINE IN SERVICE, Roger Taylor, Mem.Am. Soc. M. E. An article of a strictly mathematical nature not suitable for abstracting. Attention is called to it because it presents data as to procedure followed in putting a steam turbine into service not easily found in print elsewhere. Such features as leveling, alignment, checking bucket clearance, adjustment of thrust and step bearings, valve setting and governor adjustments are considered. The article is the first of a series. (*Power*, vol. 50, no. 16, Nov. 22, 1919, pp. 578-582, 9 figs., *p*)

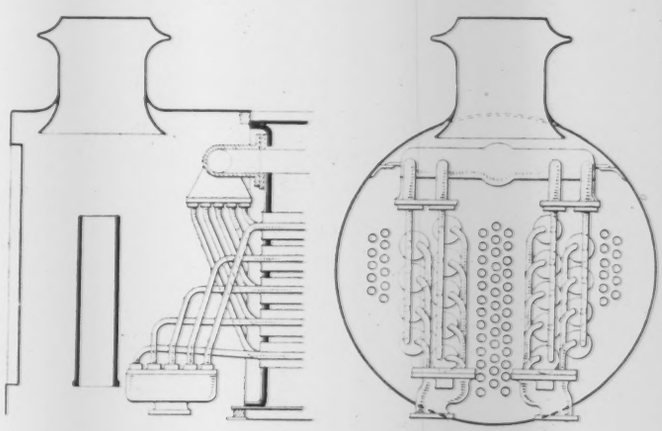


FIG. 16 HORWICH LOCOMOTIVE SUPERHEATER

RAILROAD ENGINEERING

HORWICH SUPERHEATER FOR LOCOMOTIVES. A number of heavy 0-8-0-type locomotives at present being constructed at the Horwich Works of the Lancashire & Yorkshire Railway are fitted with the new type of superheaters, shown in Fig. 16.

In this superheater there are three separate headers, one at the top and two at the bottom of the smokebox, the latter being in direct communication with the cylinder steam chests. Saturated steam from the boilers enters the top header and branches right and left from a central chamber. Steam passes along small pipes

enclosed in large flue pipes in the ordinary way, traversing the length of the boiler toward the firebox, returning toward the smokebox, then again toward the firebox and finally to the lower headers in the smokebox, thence to the smoke chest and cylinders. The large flue tubes are arranged in two vertical rows on each side, and in the particular boiler illustrated there are twenty elements. This arrangement gives a short direct connection between the lower headers and the cylinders for the passage of steam.

Owing to the fact that the saturated- and superheated-steam receptacles are separated from one another and the usual smokebox steam pipes dispensed with, any loss of superheat occurring during the passage of steam from the outlet ends of the superheater headers to the steam chests is reduced to a minimum.

It is also claimed that the parts are readily accessible and cleaning facilitated. (*The Railway Gazette*, vol. 31, no. 18, Oct. 31, 1919, pp. 556-557, 3 figs., *d*)

The low-pressure end has a header made of 16-in. pipe and carrying a 6-in. dry pipe (Fig. 17), the dry pipe being welded at each end to a plate, which, in its turn, is welded to the header. On the inside opposite the gas-admission side the dry pipe has a slit 2 in. wide for its entire length through which the gas passes into the dry pipe and thence to the suction pipe. To the bottom of the dry pipe is riveted a curved baffle plate which changes the direction of the gas flow from the coolers so as to throw out some of the entrained liquid. Both dry pipe and header are given a slight pitch toward the dead end, where liquid may drain into the header from the dry pipe and from the header into the coolers. The circular plate in the outlet end of the header has an opening of segment shape into the header, the opening being immediately above that into which the dry pipe is welded and so situated as to pass gas collecting at the top of the header to the suction pipe.

The conditions created by this and other means are such that

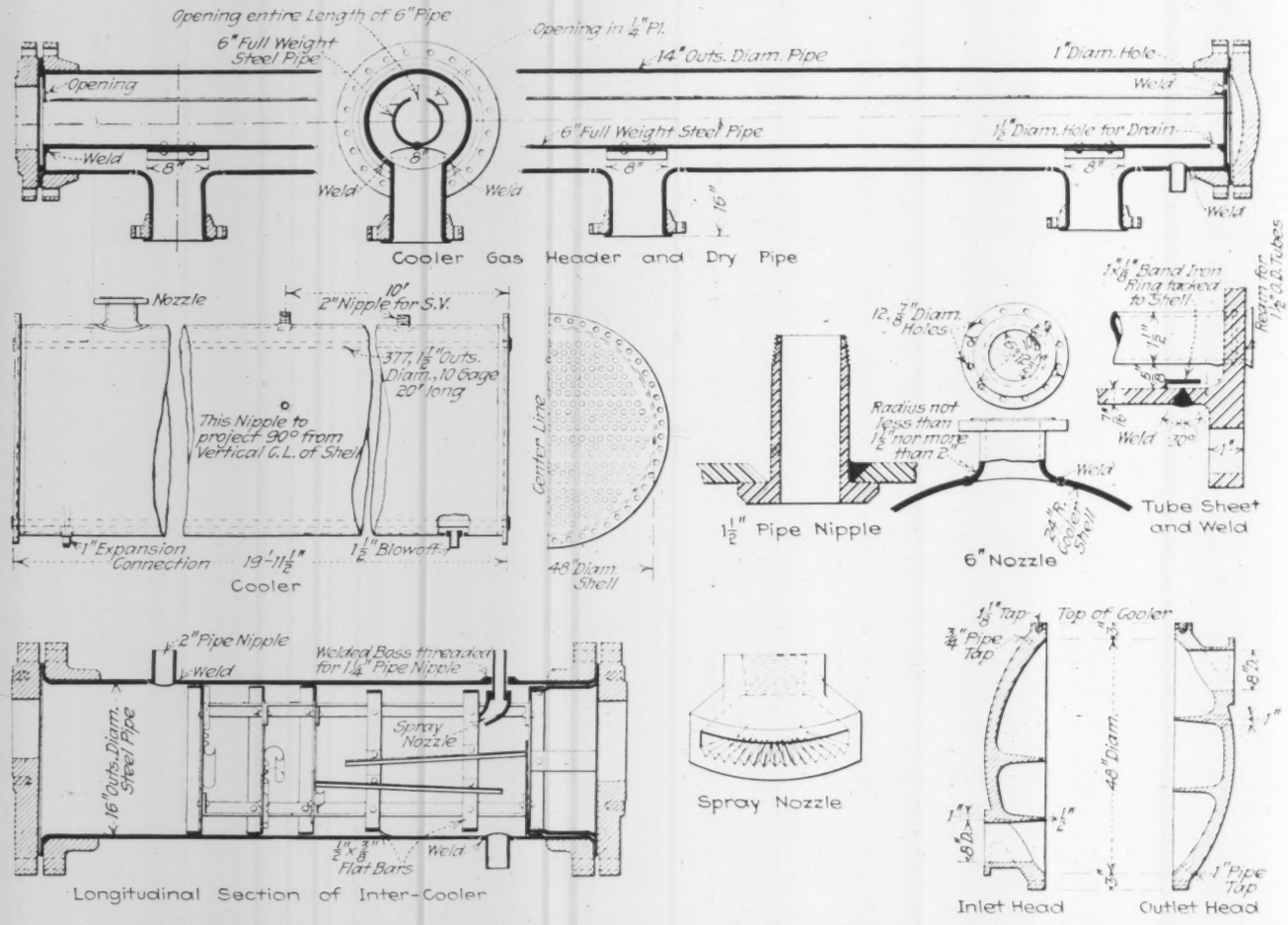


FIG. 17 COMPRESSOR OF THE T-WHARF PLANT OF THE QUINCY MARKET COLD STORAGE COMPANY, BOSTON, MASS.

REFRIGERATING ENGINEERING

Improved Compressor at Quincy Market, Boston

QUINCY MARKET COLD-STORAGE PLANT AT BOSTON. Chas. H. Bromley. Description of the so-called T-wharf plant of the Quincy Market Cold Storage and Warehouse Company. The station is of 500 tons rated capacity in one compound high-speed feather-valve ammonia compressor driven by a 600-hp. synchronous motor. The most remarkable part of it is this compressor.

Essentially it is of the standard Laidlaw type, but has a special arrangement of gas connections and gas intercooler.

The compressor has a 24-in. stroke, a low-pressure cylinder of 27-in. bore and a high-pressure cylinder of 15-in. bore. The low-pressure cylinder has 12 valves each with a free opening area of 9 sq. in., and the high-pressure cylinder six valves of the same area.

liability to slop over is remote under normal conditions, and, in any event, a slopover comes gradually and not in one smashing flow. There is a condition which tends to produce a slopover when the rate of feeding liquid to the brine coolers is suddenly and markedly reduced. The expansion-line nozzle inside the cooler projects the liquid upward at an angle on a line with the top far end of the cooler. Feeding may be so rapid that the liquid in the cooler will pile up at this end and thus leave more disengaging volume between liquid level and cooler top at the gas outlet end than existed before increasing the rate of liquid flow.

Another interesting feature of the compressor is the intercooler. The cooling medium is liquid ammonia taken direct from the liquid receiver. The principle of the intercooler is identical with that of the open feedwater heater, and the intercooler is provided with trays and baffles just as is the open heater. Liquid direct from the main liquid receiver is run through the intercooler, and what is not evaporated goes to the brine coolers. The gain is, of

course, twofold: First, the gas is cooled, reducing the volume to be handled by the high-pressure cylinder; second, liquid in cooling by its own expansion uses up, say, 15 per cent of its cooling effect in cooling itself. Compared with its condition in the liquid receiver, this liquid passed through the intercooler has already lost this in a most useful way—the liquid as well as the gas has benefited by the heat exchange in the intercooler. As the intercooler pressure is 60 lb. and that in the brine coolers 5 lb., the liquid is trapped just before it reaches the coolers. It is convenient to use the last or No. 8 condenser as an intercooler, taking the gas before it goes to the liquid-gas intercooler.

The designer has cleverly obviated the use of a concrete crib at the harbor end of the suction pipe. This suction is 10 in. in diameter and at the harbor connects with a 10 x 8 x 8-in. Y. At each 8-in. outlet of the Y is a gate valve, a short nipple on the end of which is fitted with 12 ft. of 8-in. flexible rubber hose. On the end of the hose is a strainer made of 12-in. pipe, slotted to give capacity considerably greater than that of the 10-in. suction.

Several other interesting features at the new plant are discussed and illustrated in the original article. (*Power*, vol. 50, no. 18, Oct. 28-Nov. 4, 1919, pp. 638-644, 9 figs., *d*.)

STANDARDS

THE MASS OF THE LITER OF AIR AND GAS MIXTURES. Critical abstract of a memoir on The Mass of the Liter of Air, published by Prof. A. Leduc in vol. 16 of the Travaux et Mémoires du Bureau International des Poids et Mesures.

Objections are made to the use of air as a standard of measurement. When this is done the composition and density of the air are tacitly assumed to be constant, the data having been reduced to normal temperature and atmospheric pressure. But the air density is not constant and the buoyancy is sufficiently affected by a barometric change of a few millimeters to upset balance established even between lumps of quartz and of platinum, each weighing one kilogram.

While the air density does not fluctuate widely, under ordinary conditions, such deviation as takes place is well within the limits of precise measurement.

The air measurements are also affected by the composition of the air. Thus, oxygen, being heavier than nitrogen, becomes concentrated in the lower atmosphere, this tendency, however, being counteracted by winds and convection currents. Further, air in laboratories may be seriously contaminated by water vapor and carbon dioxide, which are removed before analyzing the air but usually disregarded in density determinations.

There is another objection to the use of a mixed gas like air as a standard.

Dalton's law was formulated in ignorance of the fact that nearly all gases are more compressible than they should be according to the law of Boyle and Mariotte. Leduc's own experiments would lead to the following conclusions:

If we have equal volumes of two gases, *A* and *B*, at equal pressure *P* and allow the gases to mix, *A* will not, in the doubled volume, be at the pressure $P/2$, but at the pressure $P/2 + \varepsilon$, because the gas is more compressible than it should be; similarly *B* will be at a pressure $P/2 + \varepsilon_1$, and the pressure of the gas mixture will be $P + \varepsilon + \varepsilon_1$; but this $(\varepsilon + \varepsilon_1)$ is not a constant and depends upon the nature of the gases. In one series of experiments to demonstrate this Leduc and Sacerdote connected two flasks of equal volumes, charged with various gases, by a three-way cock, and hastened the mixing of the two gases by cooling and heating the one or the other vessel and by shaking. Diffusion was very slow; sometimes it took days and weeks to obtain a mixture of constant composition (as shown by analysis) and pressure. In the case of two substances like CO_2 and N_2O (which physically differ little) there was no distinct increase in pressure; in the case of two gases like H_2 and SO_2, physically dissimilar, there was a pressure rise of 3 mm. It is clear, therefore, that the nature of the gases has to be considered. What is less clear—from the brief account of the memoir, at any rate—is whether all possible chemical and other disturbing effects can be allowed for in such experiments, and whether Leduc's version of Dalton's law meets the required conditions, namely, that the volume occupied by a mixture of gases is equal to the sum of the volumes occupied by each of the constituent gases at the same temperature and at the pressure of the mixture. As regards the atmospheric mixture of nitrogen and oxygen, the ε may practically be disregarded, Leduc finds; but the fact could not be presumed.

In the experiments made to determine the mass of the liter of air it was found that the rare gases, excepting argon, and hydrogen would only affect the 5th decimal of the air density, which is uncertain anyhow and may hence be neglected.

Samples of air taken in different parts of France and in Africa at various altitudes show that the oxygen proportion by weight varied between 0,2305 and 0,2325 and further the oxygen proportion was lower than the average in the north of France at sea level, which, it is suggested might account for the slightly lower oxygen values of Rayleigh.

The final result is that the liter of air at 0 deg. cent. and 760 mm. barometer weighs 1.2928 grams when $g = 980{,}665$. Under one megabar, taking the density of mercury as 13.5951 and g as 980.97, the mass of the liter of air would be 1.2759 grams. (*Engineering*, vol. 108, no. 2809, Oct. 31, 1919, p. 569, *t*.).

STEAM ENGINEERING (See also Power Plants and Railroad Engineering)

HEAT TRANSMISSION IN BOILER FLUES, Michael Longridge. In carrying out tests on a new type of boiler some years ago the author tried to determine whether heat transmission in boiler flues is proportional to the product of the density and speed of gas when the water circulation is well maintained. While the tests were not exhaustive enough to answer this question in a positive manner, enough data were secured to create a doubt as to its truth.

If the transmission per square foot of air per degree temperature difference were strictly proportional to the product of the density and speed of the gas the values of $H/\triangle \varrho u$ (where H is the average B.t.u. transmitted per sq. ft. of air; $\triangle$ mean temperature difference between gas and steam or water; ϱ mean density and u mean velocity) would be constant in each case though the constant values might be different for the plug flue for the evaporator and for the economizer.

Actual test data show that in the case of the economizer the values are approximately constant and therefore approximately in accordance with the law $H \triangle \varrho u = \text{constant}$.

In the case of the evaporator the variation is greater, and for this there are two reasons: First, greater uncertainty as to temperatures and radiation losses; second, the fact that owing to some of the tubes being bent the gas current was not evenly distributed over the cross-section of the flue.

In the case of the plug flue the variation is considerable, but here it must be remembered that the plug was quite hot at one end and more than red hot at the other end, and therefore the radiation from it was very great. As a result of this the heat absorbed by the flue plate was much greater than if the plate had received heat from contact with the hot gases only.

It appears, therefore, that the general law, namely, that heat transmission in boiler flues is proportional to the product of the density and speed of gas when the water circulation is well maintained, is well supported. (Abstract from an unpublished copy of a report made by the author who was Chief Engineer of the British Engine Boiler and Electrical Insurance Company, Ltd., of Manchester, England, on December 31, 1909. While not of recent date the report is of interest and this is its first publication, a copy having been secured through the courtesy of Daniel Adamson, Mem. Am. Soc. M. E.; *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

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136 Federal St., Boston

Yearly subscription $4.00, single copies 40 cents. Postage to Canada, 50 cents additional; to foreign countries $1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Our New President and New Past-President

Major Fred J. Miller, the new President of The American Society of Mechanical Engineers, brings to this important position the fruits of many years of wide experience in large affairs. In the introduction of the President-elect on the evening of the President's Reception at the Annual Meeting, it was stated that "for 20 years he was a journalist, since which time he has been engaged in the business of factory management, an expert on factory management. He served for five years on the Council of this Society, and for four years as Trustee of the United Engineering Society. His work as Trustee of the United Engineering Society had to do with the reorganization of its finances and other features, but principally with the work of reorganization. During the past year he has had made a survey of the machinery—the office machinery—of this Society, and he has advised with regard to the development of MECHANICAL ENGINEERING, the Journal of the Society. He had also rendered very distinguished service in the cause of his country during the war."

The position of President of the A.S.M.E. has come to be in reality a position demanding a large amount of time and personal attention, not only to Society affairs almost overwhelming in amount, but to public matters of broad scope in which the interests of engineers are involved. The Society is to be congratulated on having for its leader during the coming year one whose experience and intimate acquaintance with the Society so well qualify him to conduct affairs which need the sound judgment of an able executive and officer. An account of Major Miller's life will be found in Section Two of this number.

For the work of Dean M. E. Cooley, the retiring President, the utmost gratitude is felt by all the members of the Society and all who have been acquainted with his constructive genius. Making the trip from Ann Arbor, Mich., to Society headquarters each month, and sometimes oftener, and giving practically half his time to his presidential duties, he has displayed a devotion to the cause of the profession for which the Council and his fellow-members in the Society have the fullest appreciation. His grasp of Society activities is shown in his presidential address printed elsewhere in this number. The manner in which he has handled the many problems that have arisen, with combined forcefulness and geniality, has been most happy and effective and has won the admiration of his associates and his many friends.

Engineering Index Issued in a New Form

The Engineering Index has now been conducted by The American Society of Mechanical Engineers for a period of one year, and as a result of this experience a change has been made in the arrangement of the items comprising the Index, beginning with this number of MECHANICAL ENGINEERING. Heretofore the classified system has been employed whereby the items were grouped under several broad headings, such as Mechanical, Electrical, Civil and Mining Engineering, Marine and Railroad Engineering, Organization and Management, General Science, etc.

During the year suggestions have been solicited from the membership for the improvement of the Index, with the result that practically all of the criticisms or suggestions have pointed in the direction of adopting a simple dictionary arrangement of the items rather than the classified arrangement. This led the Publications and Papers Committee of the Society to make an investigation and secure the opinions of engineers, librarians, and others who have given attention to the matter, which have confirmed the opinions previously received to the effect that the alphabetical arrangement, all things considered, is to be preferred.

To turn from a classified system to an alphabetical one presents many problems, to solve which requires time and effort. Undoubtedly many suggestions can be made for the further improvement of the Index as it appears in the current issue of this Journal, and it is hoped that those who consult the Index will feel free to communicate with the editor with regard to any deficiencies and give, if possible, constructive suggestions for future improvement.

Engineering Societies Employment Bureau Completes a Successful Year

During the past year the four Founder Societies have jointly maintained in the Engineering Societies Building an Employment Bureau, open to all engineers, and especially extending its aid to discharged engineer officers and men. During the year the Bureau has interviewed over 20,000 men and has handled nearly the same number of applications. At present there are approximately 5000 men registered, many of whom, however, are already employed and have entered their names in order to advance themselves should opportunity offer. About 2500 positions are now available. Here is an opportunity for effective coöperation. Business men and engineers who are seeking new blood for their organizations can without question profit by communicating with the manager of the Bureau, Mr. W. V. Brown, who should be addressed at 29 West 39th Street, New York, N. Y.

It should not be inferred that because of the smaller number of positions available men are not in demand. On the contrary, good men are constantly in demand and many of the positions now available call for engineers of particular qualifications. Those seeking engineering positions will therefore find it advantageous to enlist the aid of the Bureau.

National Public Works Department Association Holds Conference in Washington

The National Public Works Department Association, which grew out of a conference called by Engineering Council, and held last April in Chicago, will meet at the Willard Hotel in Washington, D. C., on January 13 and 14. The purpose of the conference is to discuss the Jones-Reavis bill, which is now being considered by Congress, and which proposes far-reaching changes in the organization of the Federal Government. This bill, to which reference has frequently been made in these

columns, proposes to create a Department of Public Works to replace the Department of the Interior. It is the primary object of the bill to assemble under one head all of the engineering activities of the Government and to place under the jurisdiction of existing appropriate departments such activities as are of a non-engineering character. The various details of the bill will be found in the August issue of MECHANICAL ENGINEERING (page 709).

The Tuesday session of the conference will be given over to a discussion of various committee reports and of the Jones-Reavis bill itself. The practical results achieved by the public works departments of several of the states will also be discussed. It is the hope of the National Public Works Department Association that every engineering organization in the country be represented in this conference, for the bill is one not alone of interest to engineers, but to the country at large.

Annual Volume of Engineering Index to Be Alphabetically Arranged

The Engineering Index, which has been a monthly feature of MECHANICAL ENGINEERING during the past year, will later be issued in the form of an annual volume, according to the practice followed by the former publishers of the Index for many years past.

To meet the demand for an alphabetically arranged index, however, which a consensus of opinion clearly indicates is the most convenient form for reference purposes, the items have been entirely regrouped according to this plan, instead of following the classified arrangement of the Index as it has appeared in MECHANICAL ENGINEERING and in the previous annual volumes. By introducing many cross-references the engineer will be able to find under one heading all the references to any one subject.

For instance, under the new plan references to screw-thread gages will be found under the heading GAGES, *Screw-Thread*, instead of MECHANICAL ENGINEERING, GAGES, *Screw-Thread*. In other words, one will turn directly to the reference rather than attempt first to classify it as Electrical Engineering, Civil Engineering, Mining Engineering, Mechanical Engineering, etc.

The work of regrouping the 12,000 items which form the 1919 Index has been done entirely by engineers, men familiar with the terminology of the profession and thus eminently qualified to compile a work of this character. No expense has been spared to make the 1919 Index an accurate and reliable compilation of intrinsic merit. It will be a book for the desk of the individual engineer as well as for the reference library—one which every practicing engineer should own.

Conference on National Safety Codes

Within sixty days a definite start will be made in the development of uniform national safety standards, beginning with those subjects on which rules are now being formulated or revised by state or other authorities. This seems certain as a result of the Conference called by the Bureau of Standards and held at Washington, D. C., December 8 and 9.

This meeting was attended by about 100 representatives of the trade associations, engineering societies, state industrial commissions and labor departments, government officials, insurance companies and bureaus, and large employers of labor.

The program included an exposition of the large number and variety of conflicting safety codes in existence which have been formulated by various state, insurance, and other organizations, and an outline of the efforts which have been made to secure uniformity. It was evidently the unanimous feeling of those present that such uniformity had become not only extremely desirable but almost imperative, in view of the embarrassment and expense to which employers and others are subjected when different standards are enforced by different authorities, and when these standards are changed at, in some cases, frequent intervals. The Conference voted unanimously to approve the plan of formulating safety standards under the general auspices of the American Engineering Standards Committee.

The vote of the Conference on December 8, already referred to, means that the formulation of uniform safety codes will be undertaken according to the regular procedure of the American Engineering Standards Committee as just described.

The Conference on December 8 further voted that to expedite early action, a general advisory committee should be formed to include representatives of all national associations, state commissions, and others legitimately interested, to survey the whole field of safety standards and recommend what standards should be undertaken first and what organizations should sponsor them. The conference recommended that such representative committee be organized by the National Safety Council, the Bureau of Standards, and the International Association of Industrial Accident Boards and Commissions, acting jointly. At an informal meeting of representatives of these three organizations, on December 9, plans were made for organizing the general advisory committee at once, and probably arranging for a meeting in January. Before this time, up-to-date information will be gathered as to what codes are now being written or revised in the various states and the general advisory committee will probably recommend that these subjects be given first attention. This committee will report to the American Engineering Standards Committee not later than February 1, and the definite assignment of sponsorships to the National Safety Council, the Bureau of Standards, and others will doubtless follow. The National Safety Council's participation in this work will be largely in the hands of the Engineering Section, in coöperation with the industrial sections especially interested.

The Value of Sheet Asbestos on Hot Pipes

The following notes on recent research work carried on at the research laboratories of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., have been contributed by T. S. Taylor:

While conducting some simple tests on the relative thermal resistance of layers of asbestos paper when applied loosely and tightly, respectively, some rather interesting results were obtained. In the preliminary tests, it was observed that a bare tin vessel containing hot water would cool less rapidly than the same vessel when wrapped tightly with one layer of 0.013 in. sheet asbestos. This observation, which is just the opposite to the usual ideas held by most people, was carefully checked by fixing up identical tin vessels, one being left bare and the other covered tightly with sheet asbestos, and then obtaining the cooling curves for each when placed under similar conditions. The uncovered one cooled much more slowly than the one covered with asbestos. However, to obtain results from conditions more nearly like those met in practice, heaters were made so as to slip into vessels 4 in. in diameter and 20 in. long and the temperature excess of the air at the center of the vessel above room temperature measured, for various inputs and surface conditions.

From these tests, it has been found that an asbestos-covered hot-air pipe loses 33 per cent more heat from its surface than a bare one. To reduce the heat loss of the covered pipe so as to be equal to that of the bare pipe would require a coating of asbestos, as usually applied, at least $\frac{1}{16}$ in. thick. To make the heat loss of the asbestos covered pipe $\frac{3}{4}$ that of the bare one, would require a layer of asbestos about 1/9 in. to $\frac{1}{8}$ in. thick. However, if the asbestos is put on loosely, three layers of 0.013 in. will reduce the heat losses to practically that of a bare pipe. Even with a dust-covered surface, such as usually exists on furnace pipes, the asbestos-covered pipe will lose at least 20 per cent more heat than the bare one.

The results show that it is not economical to cover hot-air pipes with the usual thin layer of asbestos, not only on account of the initial cost of labor and material but on account of heat losses later. Calculations based upon the data obtained indicate the possibility of reducing the heat losses so that there will be a saving of one ton of coal in sixteen. A more complete account of the experiments will appear shortly.

Autogenous Welding of Boilers and Pressure Vessels

An important announcement has been received from the Steam Boiler and Fly-Wheel Service Bureau relative to the position it has taken in regard to autogenous welding in steam-boiler repair practice, at the suggestion of the Engineers' Committee of the Bureau. This Committee, which consists of representatives of all the insurance companies writing boiler insurance in the United States, has, in a report recently adopted unanimously, interpreted the application of Par. 186 of the A.S.M.E. Boiler Code on welding to boilers and other pressure vessels, for both new construction and repairs, in order to insure uniform practice in the acceptance of autogenous welding. Inasmuch as this report sets forth the position of the insurance companies with respect to the insurability of steam boilers repaired by autogenous welding, it is here reproduced with the permission of the Steam Boiler and Fly-Wheel Service Bureau.

By "autogenous welding" is meant any form of welding by fusion, that is, where the metal of the parts to be joined or added metal used for the purpose is melted and flowed together to form the weld. Such welding is accomplished by the oxy-acetylene, hydrogen or other flame processes, or by the electric arc; no distinction is made between any of these processes. The general rule to govern the acceptance of such welds in insured vessels is that prescribed by the Boiler Code of The American Society of Mechanical Engineers, Par. 186, as follows: "Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code, and where the safety of the structure is not dependent upon the strength of the welds."

The following illustrations will serve to point out where such work should be accepted or rejected.

1 Any autogenous weld of reasonable length will be permitted in a staybolted surface or one adequately stayed by other means so that, should the weld fail, the parts would be held together by the stays. It is necessary for the inspector to use judgment in interpreting the meaning of "reasonable length" as given above, since it may vary in different cases. In the average case it should be not more than 3 ft. Autogenous welding will not be accepted in unsupported surface.

2 The edges of the inner and outer sheets of vertical firebox boilers, or boilers of the locomotive type, may be joined by autogenous welding to form the door openings, if the surrounding surfaces are thoroughly stayed. This would also apply to other openings of a similar character in such surfaces.

3 For low-pressure plate-steel boilers operated at a pressure not exceeding 15 lb. to the sq. in., or for higher pressures in unfired vessels subjected to water pressure only, rectangular headers may be autogenously welded at the edges if the sheets are properly held together by stays. Autogenous welding of cracks and fractures in cast-iron boilers will not be permitted.

4 Fire cracks in girth seams extending from the edge of the plate to the rivet hole may be autogenously welded provided the cracks are properly prepared by cutting out the metal at the crack in the form of a letter "V" to permit fusion through the entire thickness of the plates. Similar cracks in girth seams located between the rivet holes may also be autogenously welded, provided the cracks do not extend beyond the edge of the lap of the inner plate. In the latter class of cracks it is advisable to drill a hole not exceeding $\frac{3}{8}$ in. in diameter at the end of the crack before the weld is made. Cracks extending from rivet hole to rivet hole on girth seams cannot be welded. Calking edges of girth seams may be built up by autogenous welding between rivet holes and calking edge where the original section of the metal to be built up averages to be equivalent to one-fourth of the diameter of the rivet hole; and the portion of calking edge to be replaced does not exceed 30 in. in length in a girthwise direction. In all repairs to girth seams by autogenous welding the rivets must be removed over the portions to be welded and for a distance of at least 6 in. at each end beyond such portions. After repairs are made the rivet holes should be reamed before the rivets are redriven.

5 Stayed sheets which have corroded to a depth of not more than 40 per cent of their original thickness, may be reinforced or built up by autogenous welding. In such cases the stays shall come completely through the reinforcing metal so as to be plainly visible to the inspector.

6 Where tubes enter flat surfaces and the tube sheets have been corroded or where cracks exist between the tube ligaments, autogenous welding may be used to reinforce or repair such defects. The ends of such tubes may be autogenously welded to the tube sheets. The above-mentioned repairs for tube sheets and the welding in of tubes in the sheets, are not to be permitted where such sheets form the shell of a drum or boiler, as in the case of the Stirling type of boiler.

7 When external corrosion has reduced the thickness of plate around handholes to not more than 50 per cent of the original thickness and for a distance not exceeding 2 in. from the edge of the hole, the plate may be built up by autogenous welding.

8 Pipe lines will be accepted where the flanges or other connections have been welded autogenously, provided the work has been performed by a reputable manufacturer and the parts properly annealed before being placed in position. Such welding when made with the part in place and unannealed will not be acceptable.

9 Autogenous welded-in patches in the shell of a boiler will not be acceptable regardless of the size of such patches. Autogenous welding of cracks in the shell of a boiler (except those specified in Par. 4) regardless of the direction in which they may lie will not be permitted, unless such welding is only for the purpose of securing tightness and the stresses on the parts are fully cared for by properly riveted-on patches or straps placed over the weld. The plates at the ends of joints may be welded together for tightness, provided the straps or other construction are ample to care for the stresses on the parts so welded.

10 Reëuding or piecing of tubes for either fire-tube or water-tube boilers by the autogenous process will not be permitted.

Electric Power for Holyoke, Mass.

Within recent months the Turners Falls, Mass., Company, which is the well-known hydroelectric development company on the Connecticut River and its tributaries, made a proposition to the city of Holyoke, Mass., for supplying the electrical energy to the present Holyoke municipal power-generating plant, the distribution of this power to be over the existing wires and equipment of the Holyoke plant and the latter to discontinue the generation of power. The consumption amounts to 60,000 kw. daily.

The limit of capacity of the Holyoke generating plant has nearly been reached, sufficient condensing water is not available and a very large new investment would be necessary in a few years if it should be decided to continue the manufacture of electrical energy. These considerations have aroused a great deal of interest among engineers in the Connecticut Valley. The newly formed Engineering Society of Western Massachusetts has taken an active part in the consideration of the matter and has participated in the public meetings which have been called by the city of Holyoke to discuss this subject. The result has been that S. M. Green, Mem. Am. Soc. M. E., consulting engineer of Springfield, Mass., was retained by the city of Holyoke to investigate the project and to render an impartial verdict.

John J. Kirkpatrick, manager of the Holyoke Gas & Electric Department and an active member of the Engineering Society of Western Massachusetts, has taken a leading part in the discussion of the problem and at the November meeting of the Engineering Society of Western Massachusetts in Holyoke, November 10, at the invitation of Charles L. Newcomb, the presiding officer, spoke upon the subject of municipal ownership, which had an interesting although not manifestly direct bearing upon this topic. Mr. Kirkpatrick said that while Holyoke was not imbued with socialistic tendencies, nevertheless it had been concerned in three very successful enterprises.

When but a town of 10,700 inhabitants, it spent $375,000 in the construction of a railroad between Holyoke and Westfield to connect with the New Haven road and the Boston & Albany road.

Again, in 1872 the town voted to establish its own water-supply system and voted $250,000 for this purpose.

In 1896 the Board of Alderman passed the first vote favoring municipal ownership of the gas and electric plants. The law provides that a city shall not acquire a lighting plant until it has been so authorized by a two-thirds vote of its government passed in each of two consecutive years and thereafter ratified by a majority of the voters at an annual or special city election. In December, 1897, this ratification was secured. For the gas plant the city paid $432,295 and for the electric stations $377,252, both of which items included certain bonuses for mill powers. Subsequent enlargement of the plants brought their total value up to $2,000,000.

Mr. Kirkpatrick said that the prices paid for street lights in Holyoke are the lowest in Massachusetts. If the city had paid for its lights during the past 16 years on the basis of the lowest price charged in any city or town in the state for metered electricity in buildings and for its street lights, it would have paid

$453,745 more than they actually cost the city. The property of the Gas and Electric Department is not taxable, but if taxes had been paid during these 16 years they would have amounted to only $358,134. While water power is used to a small extent, it is not an important element in the successful conduct of the plant. "The Gas and Electric Department, as it is known locally," he said, "is one of the most successful instances of municipal ownership in the country."

Memorial to the Late Frederic R. Hutton

During the Annual Meeting of the A.S.M.E., as recorded in the account of the Business Session in this number, a tablet was unveiled of the late Frederic R. Hutton, for twenty-three years Secretary of the Society. This tablet, an engraving of which is reproduced herewith, was executed by Victor Brenner and now hangs in the reception hall of the Society headquarters. The tablet was presented with remarks by Major William H. Wiley, Treasurer of the Society, a close friend of Professor Hutton, and Acting Chairman of the Committee appointed for the preparation of this memorial. Major Wiley spoke as follows:

MEMORIAL PLAQUE TO THE LATE FREDERIC R. HUTTON

GENTLEMEN OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS:

In presenting this tablet, as Acting Chairman of the Memorial Committee appointed for that purpose, I was firmly of the belief that no words of mine would be fitting on such an occasion in speaking of a man so well known to the entire Society and whose work, as its Secretary and President, was a large part of the history of this organization, but the rest of the Committee unanimously differed from my judgment, hence I will yield to them and make a few brief remarks in tendering this memorial.

When Dr. Hutton became Secretary of the Society in 1883 the membership was 554. I was elected Treasurer in 1884 and the amount of money passing through my hands that year was, in round numbers, $6,500. With his usual energy shown in every enterprise with which he was connected, Dr. Hutton labored in season and out of season to increase the membership of the Society by every means in his power, and used wonderful tact in all such action. Naturally a wonderful success resulted from his efforts.

The Society showed its appreciation of him and of his work by electing him to the presidency in 1908, at which time the membership was 2,929 and the amount of money passing through my hands, as Treasurer, was nearly $54,000. I think I shall not say too much when I assert that a great part of the increase in membership was due to his untiring efforts. At the present time, the year ending September 30, 1919, the membership has increased to 11,082 and the money passing through my hands, as Treasurer, $375,430. I mention these figures to show that the growth fostered by Dr. Hutton was maintained by his successor.

My associations with Dr. Hutton, as Treasurer, were naturally intimate, and most pleasant. His energy is known to all of us, and as his neighbor in the Catskill Mountains for over twenty years, I can say that he threw his efforts in that section to building up and increasing the activities of the Union Chapel with which he was connected. He was busy at all times, and devoted a great deal of valuable time to this work, and, like his actions for the interests of the Society of Mechanical Engineers, his efforts in the Mountains were marked by signal success. I could dwell at great length on the work of Dr. Hutton, both professionally and socially. He has been sadly missed in this Society as well as in Twilight Park, his summer home. Notwithstanding he went to the Mountains for a well-deserved rest, yet when an appeal for any charitable object reached him, he did not hesitate to volunteer to aid as a reader or a speaker or a contributor. I am just glancing at these matters in passing to pay a deserved tribute to one who did so much for others, but the speakers who are to follow me will go more into the details of his work.

I cannot close more fittingly than to apply to our late Secretary and President, the words inscribed on the tomb of a celebrated architect who was buried near one of the finest structures he had ever erected—"If you wish to see his work, look around you."

Engineers Honor Memory of John Ericsson

Tribute to the memory of John Ericsson, the inventor of the *Monitor*, and to Cornelius H. DeLamater, the founder of the DeLamater Iron Works, where much of Captain Ericsson's work was done, was paid by fourteen professional organizations at a meeting held on the evening of December 3. The exercises, which took place in the auditorium of the Engineering Societies Building, New York, were in commemoration of the eightieth anniversary of the meeting of Mr. DeLamater and Captain Ericsson and of the thirtieth anniversary of their death, for both men after thirty years of devoted patriotic service died within the same year.

Addresses were made by Mr. H. F. J. Porter, the Hon. Charles Vezin, Jr., a grandson of Cornelius DeLamater; the Hon. W. A. F. Ekengren, the Swedish Minister to the United States, and Rear-Admiral Bradley A. Fiske, U. S. N. (retired). A feature of the meeting was the singing of Mme. Marie Sundelius of the Metropolitan Opera and of Samuel Ljungqvist, formerly of the Royal Opera, Sweden. The Swedish Singing Society Lyran of New York also rendered several selections.

H. F. J. Porter, the first speaker of the evening, presented an illustrated lecture on The Phœnix Foundry and the DeLamater Iron Works. He outlined the careers of the two men who for over half a century were associated in work of lasting value to the engineering profession and to the country in which they lived. Under the direction of Captain Ericsson, the first river, lake, and ocean vessels driven by propellers were launched near the Phœnix Foundry, at that time located at 260 West Street, New York City. Captain Ericsson was also instrumental, during his years of association with Mr. DeLamater, in bringing about many important developments in naval architecture and marine and commercial engineering. At the DeLamater Iron Works there was also initiated under his direction such naval equipment as self-propelled torpedoes, torpedo boats, torpedo-boat destroyers and submarines. Here, too, the engines of the *Monitor* were constructed, as well as the first rock drills, the first air compressors and the first ice machines.

The Phœnix Foundry has long since disappeared; the DeLamater Iron Works has given place to a Cunard line pier, and Captain Ericsson's house was recently torn down to make room for a garage. But these historic sites will at least be marked for future generations, for the organizations under whose direction the memorial meeting was held will erect in the near future suitable tablets at all three places.

Following Mr. Porter, the Hon. Charles Vezin, Jr., spoke briefly of the life and work of his illustrious grandfather, Cornelius DeLamater. The Hon W. A. F. Ekengrem, Swedish minister to the United States, paid tribute to both men, and in reviewing the life and work of Captain Ericsson, said:

It is unnecessary for me to enter upon John Ericsson's career as

an inventor and upon the services he rendered the United States and humanity. They are too well known and too well appreciated to be forgotten. But there is one feature in his noble character which I should like to mention. While John Ericsson was always faithful to the country which he had chosen as his and did not hesitate to offer her his services and his life, he loved and honored his mother country, Sweden, and never failed to render it a service when he was able to do so. His *Monitor* which he invented long before it came to practical test, was intended for the coast defense of Sweden and when the first ship of this type was built for the Swedish Navy he presented the Swedish Government armament for it. John Ericsson has spread fame and glory over the Swedish name. In that respect as in so many others he ought to be an example worthy of aspiration for subsequent generations of Swedes in this country.

The last speaker of the evening was Rear-Admiral Bradley A. Fiske, U. S. N., retired, who characterized John Ericsson as a genius and declared that through his work the cause of civilization had been advanced. He said in part:

A more sudden and complete reversal of the conditions of a situation, cannot be found in history, or any one event more fraught with important consequences. The consequences that were to follow were perceived in their main features at the time, but their full value does not seem to have been realized. It was realized that the North could establish an effective blockade, but it does not seem to have been realized that this fact made it absolutely impossible for the South to win the war. Mahan was then an obscure young officer, and had not written his epoch-making book, The Influence of Sea Power on History; and the attention of the North was so wholly fixed on the movements of the armies, that no one seems to have apprehended the fact which is now so clear, that the weak point in the Confederate situation was their line of communication across the Atlantic Ocean, and that the victory of the *Monitor* made possible and even easy, the breaking of that line.

For this reason, sufficient advantage was not taken of the power the *Monitor* gave to the Union side. Ericsson's advice was largely disregarded, too few monitors were built, many faulty imitations were constructed that failed disgracefully; and almost the whole energy of the Northerners was devoted to widely scattered and relatively feeble military operations by soldiers whose only weapons were little muskets that they carried in their arms.

Even now, so imperfect a contrivance is the mind of man, the importance of the *Monitor's* victory is not realized, and it is deemed by many as of less importance than some of the land battles in which men were killed and wounded by the tens of thousands, with no special result beyond the killing and the wounding. Even great historians often fail to realize that the thing which makes a battle important is not the number of men engaged or killed or wounded, but the effect of the battle in winning or losing the war. Many of the most important battles have been comparatively bloodless, and many of the most bloody battles have been wholly indecisive.

But while the most important result of the *Monitor's* victory was that it assured ultimate victory in the war to the Union side, it assured another important result, the increased power of navies and therefore the increased security of civilized and wealthy countries as against countries less civilized and wealthy. In other words, it assisted the cause of civilization, and the upward progress of the race.

It did this to a degree so great that it is hard to designate any other achievement that did more. As the *Monitor's* victory was due almost wholly to the genius and character of her designer, we can truly declare that no one man can be designated as having done more for the well-being of mankind than that brave and forceful and honorable and patriotic inventive engineer, John Ericsson.

Lord Leverhulme's Six-Hour Day

Lord Leverhulme, the wealthy English manufacturer who has recently visited America, is best known in this country as an advocate of the six-hour day. What his viewpoint is, the extent to which he believes the six-hour day applicable and why he advocates the short day Lord Leverhulme explained in an address before the Boston Chamber of Commerce, reported in its journal *Current Affairs* for December 8, 1919.

His plan for the six-hour day contemplates operating in two shifts and in consequence a proportionate reduction in overhead. He says: "You will find that you can pay the same wages for six hours' work as for eight hours provided you work in two shifts of six hours each and that your result in product will not be increased in cost, merely through the increased output and the reduced fixed charges; and that to the extent that the fixed charges are greater than the weekly wage bill there will be an automatic decrease in cost."

Lord Leverhulme admitted that he did not believe the six-hour day was applicable to all industries,—at least at the present time. He believes that it should be established in such industries as lend themselves for business reasons to its operations. If others follow it will be because the plan has succeeded by the sheer force of its own merit.

The strong appeal in the address was that portion devoted to a consideration of the place that domestic economy and home life should play in regulating the hours of labor in industry and it is probably this argument which would chiefly aid in selling the idea, at least in factory communities where parents and sons and daughters are all employed to a greater or less extent. He said one must remember that the housewife may have a husband and sons and daughters going to work and that their meals have to be provided for them when they return from their toil. They should go and come at times to fit in with the daily routine of the housewife, which answers the question so often asked, "Why not work two shifts of eight hours each instead of two of six hours each?" Starting early with the first six-hour shift, changing to the second at the middle of the day and completing the work early in the evening, enables a regular schedule of domestic economy to be maintained in the household, which cannot be done with the eight-hour shifts.

The guest of the Chamber of Commerce gave one warning. The plan must not be approached with the idea that it will make more money, although it may be based on the sound economic principles which make for success. The central idea of the scheme is the betterment of the conditions of industrial workmen, the making of better human beings and the realization that the road to success is along the line of our moral and spiritual resources.

CAUSES OF INDUSTRIAL UNREST AND REMEDY

(*Continued from page 23*)

industrial establishments of the country, this situation would be intolerable. The employer would be bound by contracts he made, but the labor unions with whom he dealt would not be bound.

But in so far as the "open shop" is maintained, the employer, while he may suffer without redress from unlawful acts of the labor unions, is not called upon to make agreements with them at all and, therefore, insofar as contract relations are concerned, does not care whether or not they can be held responsible. It is his own men with whom he deals. While therefore it seems clear that from every point of view the law everywhere should be amended so that the labor unions should surely be responsible for their acts and for their contracts, the matter is of less importance if only the "open shop" can be maintained in full vigor.

The members of The American Society of Mechanical Engineers are a power in industry. Their influence pervades the industrial organizations throughout the land. Their interest in these great industrial questions is manifest. The membership of your Society in the National Industrial Conference Board is an evidence of this fact, for by becoming a member of that Conference Board your Society participates in a very definite, very honest and public-spirited effort to get at the real facts by investigation and research and to educate those engaged in industry as well as the public to a sound knowledge of the truth as to industrial questions, among the most important of which is that of the employment relation.

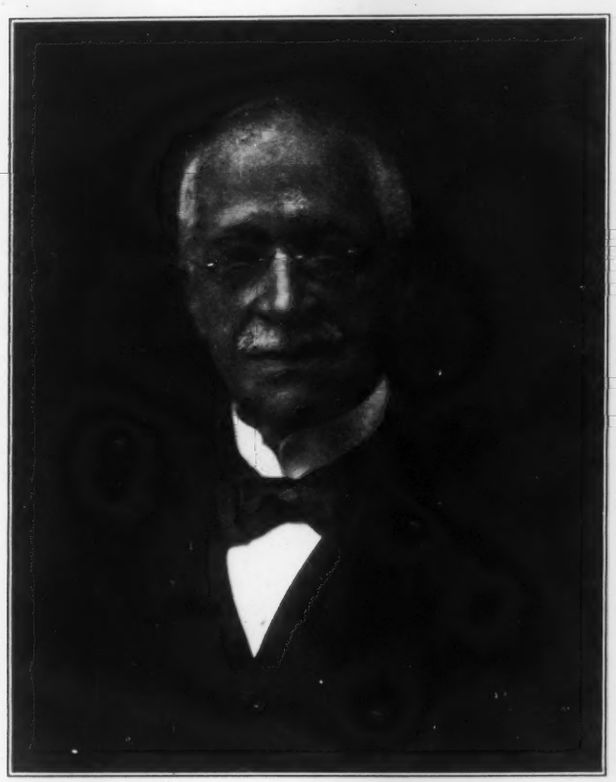
It is the duty of each member of this great body to study the question and to take a definite position as to what seems to be the single, important issue we are now facing. Shall our employment relations be developed on lines of trade-union domination, in which the employees are to be represented by the trade unions, working primarily for their own interests and the advancement of their own power on lines and by methods which to a large extent are economically, morally and legally unsound, or shall every effort be made to encourage the management of each industrial establishment to give itself wholeheartedly to the task of meeting its own employees in a friendly, sympathetic and conciliatory fashion, that by joint consideration of all questions of the employment relation, peace and contentment, coupled with the highest efficiency, may be attained?

CHARLES DE FREMINVILLE ELECTED TO HONORARY MEMBERSHIP IN THE A. S. M. E.

TO the roster of illustrious men honored by The American Society of Mechanical Engineers is added the name of Charles de Freminville, engineer of the Schneider Works and member of the French Economic Mission.

Although so well known, the careers of famous men are always of interest and so a brief biographical sketch of this French engineer follows:

Charles de Freminville was born at Lorient, France, on August 16, 1856, from a family which has honored the engineering profession for many generations. He obtained the degree of engineer at l'Ecole Centrale des Arts et Manufactures, an institution which all Americans who served in the artillery have learned to know and appreciate.



CHARLES DE FREMINVILLE

Soon afterwards he entered the service of the Paris-Orleans Railway, first as locomotive engineer and subsequently as designer and engineer. His knowledge of the English language determined his selection as the concern's representative at the Sharp Stewart Works of Manchester, England, in connection with an order placed at these works. This gave him occasion to study in all its details the practical operation of English railways.

Later on, by the request of the Orleans company, he visited America for the first time in 1885. He was accompanied by an intimate friend, Commandant Krebs, who together with Commandant Renard, played such a conspicuous part in the construction of the first dirigible *La France*, and who some years later also assisted in the construction of the first submarine *Le Gymnote*, under the direction of Gustave Zede. Mr. de Freminville was later to become the collaborator of Commandant Krebs during many years.

Having returned to France, the Orleans Railway Company commissioned Mr. de Freminville to design a new type of railway car following the lines of those used in the United States. He then designed an original type of car made almost entirely of steel, which was successfully adopted in Europe. American engineers noted this type of car with interest when they were compelled to renounce completely the utilization of wood in the construction of railway passenger cars.

In 1898 Mr. de Freminville again visited the United States with a view to studying the application of electric traction to the trains of the Orleans Railway Company.

Some time later he coöperated with his friend, Commandant Krebs, who has assumed the direction of the Panhard and Levassor Works, with a view to manufacturing industrial types of automobiles, and particularly to organize production. His efforts were especially directed to the selection of metals for the construction of light machine parts which would nevertheless possess the required strength and rigidity. He had to make his selection among metals which were then new and the qualities and defects of which were little known and often misunderstood. The construction and operation of the automobile brought about a new conception of the resistance of materials.

In 1913, in response to an invitation of Dr. Frederick W. Taylor, Mr. de Freminville again visited the United States for the purpose of studying the scientific organization of workshops. This visit afforded him the opportunity of furthering his friendship with various engineers of the Pennsylvania Railroad and a number of automobile engineers of Detroit, and of visiting the laboratories at Harvard University where remarkable experiments on the action of high pressures on the resistance of materials had been performed by Professor Bridgman.

He returned to France and dedicated himself to the application and extension of the scientific principles of organization of workshops and, together with Prof. H. Le Chatelier, endeavored to attract the attention of French industrial manufacturers to the necessity of organizing their plants in order to obtain an intensive production. He emphasized always the great importance of the work done by Frederick W. Taylor, and undertook to show that it is necessary to take into account the human factor in the organization of the works.

When the war came he became engaged in the manufacture of projectiles. His attention was called to the solution of the many problems which arose from the fact that it was necessary to use steels coming from different sources; he also undertook to apply in the manufacturing operations the best methods of organization.

He was particularly successful in the reorganization of systems of work in the shipyards of Penhoet (St. Nazaire), which were converted into a school of application of scientific methods to the most varied kinds of work, such as the manufacture of machines and the construction of ships with all the specialties that such construction entails.

Mr. Eugene Schneider, desiring to make application of new methods in his establishments, which are by far the greatest industrial works in France, associated Mr. de Freminville permanently with the Schneider works after having made certain that under his influence the new ideas of organization were accepted by the personnel and effected important developments in production. Mr. de Freminville's task was singularly facilitated by the personal support of Mr. Schneider, who has known how to inspire his personnel with a faithfulness that is rarely found in industry.

Mr. de Freminville has been President of the Section of Transport of the Society of Civil Engineers of France. He is a member of the Council of the Society for the Encouragement of National Industry, of the International Association for the Standardization of Testing Methods, of the Taylor Society, etc.

Resolution by Buffalo Section on Aims and Organization Report

At a meeting of the Local Section of the A. S. M. E. of Buffalo, November 18, 1919 the following resolution was presented and adopted:

Resolved, That the Buffalo Local Section of The American Society of Mechanical Engineers hereby approve the Report of the Committee on Aims and Organization as presented at the Spring Meeting; this Section considers that the work done by this Committee cannot but lead to broader opportunities and greater usefulness for our Society. This Section, however, cannot refrain from expressing its appreciation of the action taken in amending paragraph sixteen of the Report as presented at Detroit. We believe that The Journal can be made a means of far greater usefulness.

[The paragraph 16 referred to in the above resolution calls for the development and broadening of MECHANICAL ENGINEERING. The action at Detroit favored this, but advocated continuing the publication for the present as a monthly journal instead of publishing it weekly as recommended in the original draft of the report. The resolution above by the Buffalo Section, however, favors the full plan of development, which includes weekly publication.—EDITOR.]

NEWS OF THE ENGINEERING SOCIETIES

Reports of Meetings of Electrical Engineers, Taylor Society, Engineering Society of Western Massachusetts, Railroad Fire Protection Association, National Founders' Association, etc.

New York Section of the American Institute of Electrical Engineers

A meeting of the American Institute of Electrical Engineers was held at the Engineering Societies Building on the evening of December 10 for the purpose of organizing a New York Section of the Institute. The necessary formalities were carried out, by-laws were adopted, and the following officers were elected: Chairman, H. W. Buck; Secretary-Treasurer, H. A. Bratt; Executive Committee, the Chairman, the Secretary-Treasurer, E. B. Craft, W. S. Finlay and Farley Osgood.

There was no discussion regarding details of the work of the Section. The by-laws adopted provide that the Executive Committee of five should be the governing body and should manage the affairs of the Section. It is assumed that the scope of the Section will be identical with that of the other sections of the Institute throughout the country.

Taylor Society

Endorsement of collective bargaining and of both trade unions and shop unions, the one to supplement the work of the other, was a prominent feature of the annual meeting of the Taylor Society, held at New York on December 5 and 6.

H. K. Hathaway, consulting engineer in management, Philadelphia, spoke on Standards: Their Nature, Purpose, Necessity. He observed that standards of accomplishment are dependent upon standards of equipment, materials, methods and product and that lower labor costs, which make higher wages possible, are brought about by such methods as continuous straight-line handling, elimination of waste motions, new machinery, keeping accurate records, reorganization of sales and improvement in stock-keeping. He gave concrete examples of ways of effecting economy by the installation of an automatic tool-grinding machine in a machine shop, by standardizing tools, by carefully regulating the tension of belts, etc.

Two committees were appointed, one to study "unemployment within employment" and reducing it to a minimum, and the other to provide for the introduction of courses in scientific management in university curricula.

Naval Architects and Marine Engineers

The twenty-seventh general meeting of the Society of Naval Architects and Marine Engineers was held in New York, November 13 and 14.

The president of the Society called attention in his address to the recent surprising growth in American shipbuilding. He surveyed the situation in the industry from 1900 when 80 steel steam vessels of 168,000 tons were built as compared with Great Britain's figures of 567 vessels of 1,341,000 tons to the fiscal year of 1919 when the figures given, although they include only steel steamers of over 1000 tons, reached the total value of nearly 2,500,000 tons.

One of the professional papers described in detail the propelling machinery of the U. S. S. *Leviathan*, which is the largest vessel ever completed. The vessel is driven by the Parsons direct type of steam turbine arranged on four shafts and the turbine installation consists of eight separate turbines with their respective rotors. The go-ahead units, of which there are four, each driving a separate shaft, are arranged to operate in triple series; the go-astern units, of which there are also four, are arranged to operate in parallel and consist of two independent sets for the two port and the two starboard shafts, each unit driving a separate shaft. The machinery installation is so designed that under any extraordinary conditions which may arise at sea it is possible to operate the two turbines of any one shaft entirely independent of the other units. Further, all interconnecting valves and piston are so designed as to permit carrying out any change at sea without having to shut down for any appreciable length of time.

Other technical papers were: Methods Employed in the Construction of Concrete Ships, by R. J. Wig; Submarines in General—German Submarines in Particular, by Commander E. S. Land; The Application of Standardization and Graphical Methods to the Design of Cylindrical Boilers, by H. C. E. Meyer; New Developments in High Vacuum Apparatus, by G. L. Kothny; and Standard Oiling System for Geared Turbines, by J. E. Schmeltzer and B. G. Fernald.

Engineering Society of Western Massachusetts

Unusual interest both in the society itself and in the welfare of the community was displayed at the November 10 meeting of the Engineering Society of Western Massachusetts. This society was newly formed in the Spring of 1919 and an account of its organization meeting appeared in the July issue of MECHANICAL ENGINEERING, page 637. The officers of the Society are Charles L. Newcomb, Mem.Am.Soc.M.E., president; C. C. Chesney, vice-president; George E. Williamson, Mem.Am.Soc. M.E., vice-president; Winfield E. Holmes, Mem.Am.Soc.M.E., secretary and treasurer. The headquarters of the Society are in Springfield and its present membership, which includes engineers of all classes, closely approaches three hundred.

At the fall meeting were gathered engineers from all over Western Massachusetts. They spent the afternoon in visiting some of Holyoke's plants of engineering and industrial interest, where they were cordially received and shown all points of interest.

At the evening meeting, held at the Hotel Nonotuck, President Newcomb delivered an interesting opening address of welcome in which he touched briefly upon the engineering characteristics of Holyoke and its origin, founded upon its early and maintained water-power development and upon its dam, over a thousand feet in length, thirty feet high and with a potential horsepower of 45,000.

The principal speaker of the evening was H. W. Rogers of the Power and Mining Engineering Department, General Electric Co., Schenectady, N. Y., who delivered an illustrated address on Industrial Applications of Electric Power. Other speakers were John J. Kirkpatrick, manager of the City of Holyoke Gas and Electric Department, on Municipal Ownership of Public Utilities, and W. E. Holmes, upon the need of the active interest of members in the society.

A second meeting of the Engineering Society of Western Massachusetts was held on December 16 in Springfield, Mass., at which Charles Spofford, of Boston, Mass., spoke on Some Architectural Features of Boston Army Supply Base, and Frederic H. Fay, also of Boston, on The Proposed Springfield-West Springfield Bridge.

Railroad Fire Protection Association

The best methods for handling and storing fuel oil and inflammable liquids were among the topics discussed at the annual meeting of the Railway Fire Protection Association held at Chicago

on November 18, 19 and 20. An extensive report specifying rules and regulations for the storage and use of fuel oil and for the construction and installation of oil-burning equipment was presented by the Committee on Oil-Burning Appliances.

A technical paper on Fuel Oil versus Coal for Locomotives, by A. M. Schoen, contained many recommendations concerning the various kinds of fuel oil, the methods of handling oil and the fire hazard involved. "The large tanks," according to Mr. Schoen, "should be at a distance of not less than 350 ft. from buildings or other combustible property, and this may well be made the minimum distance from the main line of the road as well, owing to the fact that should the tank be on fire and a strong wind blowing in the direction of the tracks, the burning gases and dense smoke could be driven a considerable distance, and if the tank is not sufficiently isolated the operation of the main-line trains might be affected for a considerable time. Also the tanks should be so located and protected that under no circumstances could the oil reach streams, either flowing or tidal, by means of which it might be carried into the proximity of destructible property. It is strongly recommended that the fueling of tenders by gravity pressure be avoided, in view of the danger of the entire contents of the tank escaping in event of accident. Most approved practices would require the oil to be pumped into the tender from reservoirs constructed below the grade level, which would permit of the flow being promptly shut off in event of accident to the piping or apparatus. These wells can be filled at regular intervals either by gravity feed from the large storage tanks or else direct from the tank cars. These underground reservoirs, if completely covered over, may be located at such points as may be most convenient for their intended purpose. Usually they should be constructed either of reinforced concrete or steel."

The report of the Committee on the Protection of Wooden Bridges and Trestles against fire recommended: That effective spark screens be provided in the front end of all locomotives; that ashpans and grates be made tight and kept in good working order; that special places be provided for the dumping of cinders and ashes, and that grates are not to be shaken down except at safe points; that all combustible refuse such as dry leaves, dead grass, weeds, brush and rubbish be cleared away from under and around all wooden bridges; that the decks of all wooden bridges, between the rails, be covered with No. 22 galvanized iron, this to prevent sparks from setting fire to the structure should they be dropped from the locomotive; and that all wooden bridges be coated with a fireproof or fire-retardent paint.

National Founders' Association

The labor problems of the day were discussed at the annual meeting of the National Founders' Association, held in New York on November 19 and 20. President William H. Barr noted that 5800 strikes were called by the labor unions during the war, none of which occurred in non-union shops. He contended that more strikes are caused by the ill-advised conclusions or the hasty words of a foreman than through any other single cause, and advocated employee representation in order to reduce this possibility to a minimum by means of periodical meetings of foremen, discussion of policy, analysis of production plans and the emphasizing of the necessity of dealing justly with all employees.

Speaking on Industrial Unrest, George F. Monaghan, Detroit, counsel for the Association, suggested the employment of more efficient machinery and greater efficiency in management as remedies for the solution of present labor difficulties which he attributed to lack of production, the prevailing extravagance of all classes, socialistic agitation and profiteering on the part of both capital and labor. He also suggested that both employer and employee agree to adopt the present scale of wages and present profits until greater production can bring down the cost of living to the normal level.

The Industrial Association of Cleveland was described by H. P. Bope, vice-president of the Hydraulic Pressed Steel Co., Cleveland, as follows:

About five years ago ten of us got together to see how we could benefit our factory. First we realized the necessity to educate our foremen. Then we believed such a movement should not be confined to one factory, so we called together 50 leading business men of Cleveland and secured that number of members to form the association. There are 30,000 salaried employees in Cleveland and it was for their advancement as well as that of the employers that the movement was launched. A board of directors was formed, consisting of 27 employers and the same number of employees. We inaugurated monthly meetings with speakers and movies, a typical instance of the latter being a presentation of the manufacture of steel from the mining of the ore to the finishing of the steel product. Eight hundred men saw these pictures monthly. Last year in 20 meetings there was an average attendance of 1100 men—employers, superintendents and workmen. The object was to bring together the brains and the brawn and to distribute some of the brains into the brawn. The speeches were usually about 20 minutes long and were followed by an open forum. Cleveland is 500 per cent better off because of the industrial association. The foremen were broadened by mingling with the foremen of other shops and exchanging ideas and viewpoints. We have a magazine called Coöperation, which is very helpful in promoting friendly relations and affording education. We do not believe in unions—they are horizontal, whereas they should be vertical, or take in the executives and be local in their scope. We offset red propaganda by employing the vernacular of the laboring man in presenting economical truths.

Mr. Bope also referred to work being done to establish similar associations in Philadelphia, St. Louis and Detroit, and pointed out the advantages that could be derived by building a national association along the lines of the Cleveland Industrial Association.

Other papers were: Government Competition in Industry, by William H. Vandervoort; British and American Labor Problems, by Prof. J. Lawrence Laughlin; The Foreign Language Press, by Richard H. Waldo; and The Right of Individual Contract, by L. R. Clausen.

National Advisory Committee for Aeronautics

At the annual meeting of the National Advisory Committee for Aeronautics, held in Washington on October 9, the general functions of the Committee were specified as follows:

1 Under the law the Committee holds itself at the service of any department or agency of the Government interested in aeronautics for the furnishing of information or assistance in regard to scientific or technical matters relating to aeronautics, and in particular for the investigation and study of problems in this field with a view to their practical solution.

2 The Committee may also exercise its functions for any individual, firm, association, or corporation within the United States, provided that such individual, firm, association, or corporation defray the actual cost involved.

3 The Committee institutes research, investigation, and study of problems which, in the judgment of its members or of the members of its various sub-committees, are needful and timely for the advance of the science and art of aeronautics in its various branches.

4 The Committee endeavors to keep itself advised of the progress made in research and experimental work in aeronautics in all parts of the world, particularly in England, France, and Italy, and will extend its efforts to the securing of information from Germany and Austria.

5 The information thus gathered is brought to the attention of the various subcommittees for consideration in connection with the preparation of programs for research and experimental work in this country. This information is also made available promptly to the military and naval air services and other branches of the Government, university laboratories, and aircraft manufacturers interested in the study of specific problems.

6 The Committee holds itself at the service of the President, the Congress, and the executive departments of the Government for the consideration of special problems which may be referred to it, such as rules for international air navigation, method of regulation and development of civil aerial transport, technical development policies of the military, naval, and postal air service, etc.

Dr. Charles D. Walcott was elected Chairman for the ensuing year, and Dr. S. W. Stratton, Secretary.

GOVERNMENT ACTIVITIES IN ENGINEERING

Notes Contributed by The National Service Committee of Engineering Council[1]

SEVERAL bills of interest to engineers have been passed by the House and will be taken up by the Senate during the next session. These bills deal with such matters as oil, gas and coal land leasing; water power; national budget; tariff on ores, glassware, instruments, etc.; railroads; minimum wages, and distribution of motor vehicles to State highway departments. The National Soldiers' Settlement Bill has been reported to the House but has not as yet been acted upon. The details of many of these bills were published in the November issue of MECHANICAL ENGINEERING and there follow some additional data and comments of more recent date.

HIGHWAY LEGISLATION

The original bill proposing to create a national highway system controlled by a Federal Highway Commission, which was proposed by Senator Townsend, has been practically abandoned because of the opposition which has developed. It is now believed that any plan for National Highways constructed directly by the Federal Government will be unpopular with the states because only a limited portion of the state will be benefited directly by such highways. Further, the Government with its road building activities would be in competition with the states and the counties. It is believed that it will be easier for the Federal Government to hold the states up to a standard rather than to attempt to maintain the standard through its own work. No plans have been made to secure consideration of the Townsend bill at the present session of Congress.

Another highway bill which proposes a National Highway Department and Highway Commission has been introduced into the House, which aims to do away with the defects which have become apparent in the Townsend bill. It will bring the control of highway work more closely under the control of the states, at the same time giving enough Federal supervision to insure coördination and standardization in the work. The states are to be divided into ten regional areas with corresponding regional congresses having direct control of the work in their region but under the general direction of the National Highway Commission.

For the purpose of carrying out the provisions of this new act and as an initial appropriation for the creation of a National Department of Highways, the new bill proposes to appropriate $10,000,000. The Secretary of Highways would receive $12,000 per year and each National Highway Commissioner would receive $6,000 per year.

ESTIMATES FOR PUBLIC WORKS FOR 1921

The Secretary of the Treasury has approved and forwarded to Congress estimates for next year which total the unusually large sum of $283,921,810. The appropriations for public works during the fiscal year 1920 total $93,872,092. The estimates for work of particular interest to engineers and constructors are as follows:

Construction of Government buildings, including purchase of sites, $1,332,775; marine hospitals and quarantine stations, $5,204,621; fortifications, $117,793,330; military posts, $14,225,251; rivers and harbors, $53,659,265; navy yards and stations $20,606,000; Panama Canal construction and maintenance, $18,245,391; depots for coal and other fuels, $2,335,000; Reclamation Service, $20,134,000; $725,000 special appropriation for a fuel inspection system; $1,865,880 for the Bureau of Mines; $2,592,920, Geological Survey; $3,000,000 (approximate), Bureau of Standards.

The Technical News Bulletin of the Bureau of Standards describes progress in the following work: Radio Fog Signalling Experiments; Standardization of Electron Tube Symbols; Scientific Research on Electron Tube Amplifiers; Magnetic Analysis; Industrial Safety Standards; Photoelectric Spectrophotometry; Reinforced Concrete Investigation; Concrete Tanks for Storage of Oil; Oxyacetylene Welding and Cutting Apparatus; Locomotive Packing Ring Investigation; Weights and Measures Publications; Testing of Hydrometers; Thermostatic Return Line Valves for Heating Systems.

NOTES ON THE BUDGET, TARIFF, COMMERCE, ETC.

The Senate Budget Committee hearings, started Dec. 15, indicate a desire for the McCormick Bill. This bill provides a budget bureau in the Treasury which will coöperate with a budget officer in each department. The final budget shall be approved and sent to Congress by the President. The House Budget bill simply proposes to transfer the present work of the Treasury Department to the President, who will then prepare and submit an alternate budget with recommendations.

The office of the Adjutant General announces that its present policy governing the selection and appointment of members of the Officers' Reserve Corps contemplates the establishment of a competent Reserve Commissioned Personnel, individual members of which will be qualified to perform fully duties of their respective grades when ordered into active service in case of emergency. Officers commissioned in Officers' Reserve Corps to Oct. 31, 1919, numbered 52,839.

Contracts for electrical machinery for the propulsion of three new battleships have been awarded by the Navy Department. The price for the three sets is $5,500,000. According to Navy officials, electrical propulsion has been successful. The *New Mexico*, which was the first electrically driven battleship, has given entire satisfaction, and the *Tennessee*, the second to be thus equipped, will shortly be put in commission.

The Bureau of Public Roads has announced that while expenditures during 1919 for hard-surface highways will set a new record with a total of $138,000,000, this figure is small in comparison with the computed available total for 1920 of $633,000,000, the spending of which promises to be dependent chiefly on the quantity of materials present limited railway facilities can transport.

The prohibition or control of importation of dyes and coal-tar products as provided in the trading with the enemy act are continued until Jan. 15, 1920, by the passage by the Senate of the House joint resolution. The question of tariff bills was discussed on the Senate floor, with the decision that they must go over until after other legislation is considered.

The Commerce Committee of the Senate has been urged by the Chief Signal Officer of the U. S. Army to extend American cables as an aid to the development of the nation's foreign commerce. This is in connection with the testimony providing new cable lines across the Pacific.

A Corps of Civilian Engineers in the U. S. Army is proposed in a bill which is aimed specially to care for the resident engineers throughout the country and the Washington force, who have been underpaid, although in charge of some of the most important river and harbor work.

Senator Thomas of Colorado, during the closing hours of the recent session of Congress, introduced a bill for the establishment of a trained body of 200,000 railroad workers, to constitute a railroad army reserve force subject to call by the Secretary of War in the event of nation-wide railroad strikes.

[1] Engineering Council is an organization of national technical societies created to consider matters of common concern to engineers as well as those of public welfare in which the profession is interested. The headquarters of Engineering Council are located in the Engineering Societies Building, 29 West 39th Street, New York City. The Council also maintains a Washington office with M. O. Leighton, chairman of the National Service Committee in charge. This office is in the McLachlen Building, 10th and G Streets, Washington, D. C. The officers of Engineering Council are: J. Park Channing, *Chairman*; Alfred D. Flinn, *Secretary*.

LICENSING OF ENGINEERS

Committee Appointed by Engineering Council Recommends Uniform Registration Law

AT a meeting held on October 25, 1918, Engineering Council authorized the creation of a committee to make a thorough study and submit a report on the subject of licensing or registering engineers. Fifteen engineers of long experience in the various branches of the profession of engineering were selected from 13 states representing practically all sections of the United States, as well as mechanical, electrical, mining, hydraulic, municipal, sanitary, railway and structural engineering and also colleges of engineering.

The personnel of the committee is as follows:

Theodore L. Condron, Chicago, Ill., *Chairman*

John W. Alvord, Chicago, Ill.
Bion J. Arnold, Chicago, Ill.
John H. Dunlap, Iowa City, Ia.
A. Lincoln Fellows, Denver, Colo.
Farley Gannett, Harrisburg, Pa.
Arthur M. Greene, Jr., Troy, N. Y.
James H. Herron, Cleveland, O.
John Klorer, New Orleans, La.
Caleb M. Saville, Hartford, Conn.
A. M. Schoen, Atlanta, Ga.
Francis C. Shenehon, Minneapolis, Minn.
Amos Slater, Seattle, Wash.
Christopher H. Snyder, San Francisco, Cal.
John W. Woermann, St. Louis, Mo.

On December 18, 1919 this committee submitted its report to the Engineering Council, which included a "Recommended Uniform Registration Law," with the recommendation that the Council approve and endorse the bill for an act of legislation in each and every state for the regulation of the practice of engineering, architecture and land surveying. An abstract of the report is given below together with extracts from the recommended law, particularly those sections relating to the requirements for the registration of engineers.

On account of the overlapping of the work of engineers and architects in the design and erection of buildings and other structures and because of the close connection between this work and the surveying of the land and foundations upon which such structures are erected, it was deemed essential, as pointed out in the report of the committee, to provide in a single law for the registration of engineers, architects and land surveyors. By this means would not only life and health be protected but property rights as well, and to a fuller extent than if there were separate laws for each of these branches. The report was therefore carried through on this comprehensive scale, although the American Institute of Architects had previously prepared a "model law" to cover architecture and building.

Abstract of Report on Licensing of Engineers

This preliminary investigation disclosed that very pronounced views were held by engineers throughout the country, both for and against state licensing or registration. The general sentiment one year ago was more opposed to such measures than it is today. The older members of the profession did not as a rule favor licensing nor did they feel there was need for state regulation of engineering practice, while among the younger men there was a feeling that licensing or registration by the states would add prestige to professional engineers and in many ways benefit the profession, as well as individual engineers.

The advantages claimed for state licensing or registration are the same as those presumably gained by the laws regulating the professions of law and medicine, namely, that those who are incompetent and unqualified professionally to practice are unable to obtain certificates or licenses and hence both the public and the profession are protected. On the other hand, those engineers who have already attained recognized professional standing feel they not only do not need the benefits claimed for such legislation, but they fear that state licenses or certificates of registration are apt to put the seal of state endorsement on men who do not deserve it and that the public would assume that a licensed or registered engineer was thereby certified by the state as fully qualified, regardless of what might or might not be the requirements demanded before a license or certificate was granted.

However, the question has gone beyond the stage of debate, for already ten states[1] have enacted laws licensing or registering engineers, and other states are certain to enact similar laws during the present or coming sessions of their legislatures. In addition to these ten laws governing engineering practice, there are at least six states that require the licensing or registration of land surveyors, and in at least eighteen states[2] laws have been passed licensing or registering architects. Some of these ten laws are so drawn as to include both engineers and surveyors and some include engineers and architects and one or two include engineers, architects and surveyors. Moreover, these laws are not at all uniform and in several instances are likely to prove seriously embarrassing and annoying to engineers whose activities extend beyond the limits of a single state. Because of the nature of professional engineering work the practice of an engineer frequently extends over several states and therefore it is vitally important, if there are to be state regulations for engineering practice, that these regulations be made uniform so far as possible and that the engineering profession unites in wisely directing such legislation.

As stated, laws have been passed in at least 18 states for licensing or registering architects and the American Institute of Architects has endorsed and advocated such legislation, considering that both the architects and the general public are benefited thereby. Unfortunately some of the laws for licensing architects have been so drawn as seriously to interfere with legitimate engineering practice and the "model law" proposed and advocated by the American Institute of Architects contains definitions of "architecture" and "building" which, should such laws be passed and enforced, would prevent any one but a "registered architect" from planning or supervising the construction of any structure or any of the appurtenances thereto; consequently under this head would come a structure having simply foundations and girders, whether "with or without appurtenances." Under this model law proposed by the American Institute of Architects no one but a registered architect shall prepare plans for or supervise the construction of a building, and a "building" is thus defined in Section 19: "A building is any structure consisting of foundations, floors, walls, columns, girders, and roof, or a combination of any number of these parts, with or without other parts or appurtenances."

Since none but a registered architect shall have the right to design or supervise the construction of any structure or any appurtenance thereto, this matter becomes of vital importance to mechanical, electrical, sanitary and mining engineers, as well as to structural engineers.

In the State of Illinois a similar law for licensing architects was passed several years ago, the rigid enforcement of which made it necessary for engineers to unite in having a "structural engineers' license law" passed by the legislature, and now there are two laws in force in Illinois, one for architects, the other for structural engineers.

In some states the laws enacted and proposed are intended to regulate the practice of architecture, while in the other states laws have been enacted the purpose of which is simply to protect the term "architect," but not intended to regulate the practice of architecture. In Wisconsin and several other states no one may use the title "architect" without first obtaining from the state a certificate of registration as a "registered architect," but any one not an architect may prepare plans and supervise construction provided he does not style himself an "architect."

Therefore this committee at its meeting of October 13, 1919, adopted unanimously the following resolution:

[1] Colorado, Florida, Idaho, Illinois, Iowa, Louisiana, Michigan, Nevada, Oregon, Wyoming

[2] California, Colorado, Florida, Idaho, Illinois, Louisiana, Michigan, Montana, New Jersey, New York, North Carolina, North Dakota, Oregon, Pennsylvania, South Carolina, Utah, Washington, Wisconsin.

The following is the sense of this committee relative to the desirability of a law licensing or registering engineers:

Resolved: That the enactment of legislation to provide for the registration of professional engineers is desirable and necessary. Ten states have already enacted such legislation. Laws licensing architects have been enacted in several states and similar laws endorsed by the American Institute of Architects, are pending in several other states, which, if enacted, would prohibit engineers from continuing their customary and recognized practice.

The only basis on which the practice of any profession may be subject legally to state regulation is "in order to safeguard life, health and property." Land surveying does not involve matters that would ordinarily jeopardize life and health, but property rights are vitally affected by land surveying, and many states have deemed it essential to place restrictions and safeguards about the practice of land surveying. Land surveying is associated with both engineering and architectural practice.

This committee has therefore deemed it advisable and to the best interests of all concerned to include in one law, provisions for the registration of engineers, architects and land surveyors. It has recognized that the practice of engineering and architecture overlap in many instances, especially in connection with the larger projects of modern structures, where many branches of the arts and sciences are combined, involving architecture, structural, mechanical, electrical, sanitary, and other lines of engineering.

There are ample reasons why architects alone should judge as to the qualifications of those desiring to practice architecture and why engineers alone should pass upon the qualifications of those desiring to practice engineering. Hence a bill for legislation has been drafted by the committee along these lines and it is confidently hoped that the objections expressed by the American Institute of Architects against laws which might provide jointly for the registration of engineers and architects will be overcome by the terms of the bill herewith submitted.

Recommended Uniform Registration Law

This act is entitled "An act to regulate the practice of professional engineering, architecture and land surveying." Its sections deal with the enactment of the law, the appointment of a state board of registration for professional engineers, architects, and land surveyors, and the qualifications, expenses, certificates, powers, organization, meetings, receipts and disbursements, and records and reports of this board. Sections 9 and 13, extracts from which are here given, treat respectively of Application for and Issuance of Certificates, Exemptions, and Corporations or Partnerships, and the remaining sections take up questions of revocation and reissuance of certificates, the significance of the certificates, unlawful acts and penalties, public work, land surveying, and repeal of conflicting legislation.

Application for and Issuance of Certificates

Section 9: The board shall, on application therefor, on prescribed form and the payment of a fee of ———— dollars ($———), issue a certificate of registration:

Note: The application required should include a complete statement of an applicant's education and a detailed summary of his technical work. The statements made should be under oath, and should be supported by the recommendations of not less than two professional engineers, architects or land surveyors as vouchers.

1 To any person who submits evidence satisfactory to the board that he or she is fully qualified to practice professional engineering, architecture or land surveying:

Provided, however, that no person shall be eligible for registration who is under twenty-five years of age, who is not a citizen of the United States or Canada, or who has not made declaration of his or her intention to become a citizen of the United States, who does not speak and write the English language, who is not of good character and repute, and who has not been actively engaged for six or more years in the practice of professional engineering, architecture or land surveying of character satisfactory to the board. However, each year of teaching, or of study satisfactorily completed, of engineering or architecture in a school of engineering or architecture of standing satisfactory to the board, shall be considered as equivalent to one year of such active practice.

Unless disqualifying evidence be before the board, the following facts established in the application shall be regarded as prima facie "evidence, satisfactory to the board," that the applicant is fully qualified to practice professional engineering, architecture or land surveying:

Note: When the law goes into affect a large percentage of practising engineers, architects and land surveyors will be registered to preserve the *status quo*. Long-continued practice, graduation from a technical school of approved standing with subsequent years of practice, or membership in high-grade technical societies, in the absence of disqualifying facts, is accepted as *prima facie* evidence of qualification, as stated below.

a Ten or more years of active engagement in professional engineering, architectural or land surveying work;

b Graduation, after a course of not less than four years, in engineering or architecture, from a school or college approved by the board as of satisfactory standing, and an additional four years of active engagements in professional engineering, architecture or land surveying work;

c Full membership in American Institute of Architects, American Society of Civil Engineers, American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Naval Architects and Marine Engineers, or such other national or state engineering or architectural societies as may be approved by the board, the requirements for full membership of which are not lower than the requirements for full membership in the professional societies or institutes named above.

Applicants for registration, in cases where the evidence originally presented in the application does not appear to the board conclusive or warranting the issuance of a certificate, may present further evidence which may include the results of a required examination.

Note: The standard of qualification is set high for two reasons: the public welfare will be better promoted by maturer competency; and the prestige attached to the term "Registered" will be more significant for the professional men themselves. In requiring the younger, less experienced men to serve somewhat longer as assistants or understudies to older men, no hardship is imposed which will not be compensated by the fuller return in recognition after registration.

In determining the qualifications of applicants for registration as architects, a majority vote of the architect members of the board only, shall be required; and in determining the qualifications of applicants for registration as professional engineers or land surveyors, a majority vote of the engineer members of the board only, shall be required.

Exemptions

Section 13: The following shall be exempted from the provisions of this Act:

Offering to practice in this state as a professional engineer, architect or land surveyor, by any person not a resident of and having no established place of business in this state.

Note: A professional card in a journal of national circulation is an "offer to practice" in any state in the Union. It would be manifestly unfair to compel a professional man to register in every state in which he may in this way, or by letter or otherwise, express his readiness to accept an engagement.

Practice as a professional engineer, architect or land surveyor in this state by any person not a resident in this state and having no established place of business in this state, when this practice does not aggregate more than fifteen days in any calendar year; provided, that said person is legally qualified for such professional service in his own state or country.

Note: It is a distinct advantage to the people of any state to be able to call in for consultation a specialist from any other state. Such practice may be brief and often of an emergency nature.

Practice as a professional engineer, architect or land surveyor in this state by any person not a resident of and having no established place of business in this state, or any person resident in this state, but whose arrival in the state is recent; provided, however, such a person shall have filed an application for registration as a professional engineer, an architect or a land surveyor and shall have paid the fee provided for in Section 9 of this Act. Such exemption shall continue for only such reasonable time as the board requires in which to consider and grant or deny the said application for registration.

Engaging in professional engineering, architecture or land surveying as an employee of a registered professional engineer, a registered architect or a registered land surveyor, or as an employe of a professional engineer, architect or land surveyor, authorized by paragraphs 2 and 3 of this section, provided that said practice may not include responsible charge of design or supervision.

Practice of professional engineering, architecture and land surveying solely as an officer or as an employee of the United States.

Practice of professional engineering, architecture or land surveying solely as an employee of this state or any political subdivision thereof, at the time this Act becomes effective and thereafter only until the expiration of the then existing term of office of such employee.

Corporations or Partnerships

A corporation or partnership may engage in the practice of professional engineering, architecture or land surveying in this state, provided the person or persons connected with such corporation or partnership in charge of the designing or supervision which constitutes such practice is or are registered as herein required of professional engineers, architects and land surveyors. The same exemptions shall apply to corporations and partnerships as to individuals.

HENRY LAURENCE GANTT

ON November 23, 1919, H. L. Gantt died at his home in Montclair, N. J., after a brief illness. In his death the engineering profession has lost one of its foremost engineers, a pioneer in industrial management and a keen student of the human element in its relations to industry. He was associated with Frederick W. Taylor in his early work at the Midvale and Bethlehem Steel Companies and with this as a basis, and his personal ability as an organizer, he later established and successfully conducted his own consulting practice as an industrial engineer. His career was marked by original and thoughtful work, progressive in viewpoint, and effective in its accomplishment. In later years he developed a broad conception of industry as a national problem in which he regarded it essential that the man at the top should have the same close scrutiny and careful direction that has in the past been given his co-workers in the lower ranks. To these views he gave expression in a characteristically original manner in many addresses and written articles.

Henry Laurence Gantt was born May 20, 1861, in Calvert County, Maryland. He was graduated from Johns Hopkins as a Bachelor of Arts when only 19 years of age and taught for three years at the McDonough School in Baltimore County which he had attended as a boy. In 1884 he received the degree of Mechanical Engineer from Stevens Institute of Technology.

HENRY LAURENCE GANTT

Following his connection with Frederick W Taylor, he conducted his consulting practice until his death and had as clients more than a score of prominent manufacturing plants. Among these were the Westinghouse Electric and Manufacturing Co., American Locomotive Co., factories of Remington Typewriter Co., Bethlehem Foundry & Machine Co., Saco-Lowell Shops, Ingersoll-Rand Co., Amoskeag Mfg. Co., Cheney Brothers (silk manufacturers), Brighton Mills, Sayles Bleacheries and Corticelli Silk Mills.

Mr. Gantt was active in The American Society of Mechanical Engineers and served on the Council as Manager, 1908-11, and as Vice-President, 1913-15; on the Meetings Committee, 1912-17; and on the Executive Committee of this Council, 1913-14.

His papers contributed to the Society and which enrich its TRANSACTIONS comprise the following list, of which his early paper on the bonus system brought prominently to the front new features of management developed during his early work with Mr. Taylor: Steel Castings; Recent Progress in the Manufacture of Steel Castings; Bonus System of Rewarding Labor; Graphical Daily Balance in Manufacture; Training of Workmen in Habits of Industry and Coöperation; Mechanical Engineer and the Textile Industry; Modifying Systems of Management; Measuring Efficiency; The Relation Between Production and Costs; Productive Capacity a Measure of Value of an Industrial Property; Expenses and Costs; Efficiency and Democracy.

During the German trip of the Society in 1913 Mr. Gantt was a frequent speaker at the various functions and at the Leipsic meeting of the Verein deutscher Ingenieure, held jointly with our Society, aroused much interest by his discussion of Scientific Management.

Mr. Gantt was also the author of three books: Work, Wages and Profits: Their Influence on Cost of Living; Industrial Leadership (Yale Lectures); and Organizing for Work. In addition, he contributed many articles to the technical and daily press.

There grew up around Mr. Gantt several groups having as their central thought the principles which he enunciated. Among these was a circle of friends who regarded service to the community as the essential element in industry, and which it was believed could be attained by concentrating on the production of goods rather than on the production of profits. It was considered that industry required a "new machine" rather than a disrupting social movement, and the movement was thus given this unique designation.

During the war Mr. Gantt acted in a consulting capacity, first for the Ordnance Department by invitation of General Crozier, who recommended for the entire War Department the use of Gantt's production charts, employed by Mr. Gantt in his work and which had been used in the Ordnance Department. These charts are well known among engineers and constitute an important development in recording the progress of work. When General Crozier was retired as Chief of Ordnance a change in plans was made, but the charts were later used by the U. S. Shipping Board and Emergency Fleet Corporation in routing ships and in following up constructive work.

Mr. Gantt's vision of a better spirit in industry is well expressed by the following quotations from his latest book, Organizing for Work: "The community needs service first, regardless of who gets the profits, because its life depends upon the service it gets. The business man says profits are more important to him than the service he renders; that the wheels of business shall not turn, whether the community gets the service or not, unless he can have his full measure of profit. He has forgotten that his business system had its foundation in service, and as far as the community is concerned has no reason for existence except the service it can render."

At the last Annual Meeting of The American Society of Mechanical Engineers Mr. Harrington Emerson presented a tribute to Mr. Gantt, extracts from which here follow:

A TRIBUTE BY HARRINGTON EMERSON

Only a few weeks ago Mr. Gantt and I bent our heads over the same declaration of beliefs and principles, agreeing even as to words in the form it should take, a declaration of principles intended for the President, for Congress and for the people of the United States.

The old Hindu philosophy states that a man's full life is divided into four periods:

He is first a learner;
Next a doer;
He conquers the position of executive, of leader;
He becomes in the fullness of his experience a counselor.

When we were both still mainly in the doing stage, there was keen and friendly rivalry between us. It lasted into the executive stage, but as we slowly qualified to counsel, the agreement between us became close.

I regarded him as the nearest man to me, the man whose opinions I most valued, the man to whom I was most willing to turn for counsel. As we grow older many friends drop away. The more closely do old men cling to the few tried-out companions who remain.

It is my custom to place in my files a size-up, an appreciation of great men with whom I come in contact. This I find about Mr. Gantt:

An energetic, dominant nature;
Courageous and fearless, in expressing his opinions, which he never gave without careful consideration;
Very decided when once his mind was made up;
Industrious and energetic in working out a problem;
Independent in thought and action, ready in speech and quick and impulsive in manner, a clear thinker and a man of positive and decided character;
Precise and exact in his work and systematic in his activities, with a thoroughness in all his investigations, worthy of imitation and praise;
One of the great leaders in Efficiency.

At the extraordinarily early age of eighteen he had already received the degree of Bachelor of Arts from one of our youngest and greatest universities, he had already been in touch with the great living minds and through them, with the great minds of the past, and without this double opportunity any man, however naturally great, is burdened in the race. But he went on. He taught. He went to Stevens Institute; he was the student for even more than the first score of years. For the next twenty years he was a doer, little known to the wide world, but accumulating personal experience, trying himself out on new and difficult problems.

Leadership, authority, rests on the possession of four entirely distinct major qualities and as to each I appraised Mr. Gantt. The first great quality is that of goodness, of character, of good will towards his fellow man. It was this that attracted me to Mr. Gantt before I personally met him.

At the December meeting, 1901, of this Society, he presented a paper on A Bonus System of Rewarding Labor; with that clearness of thought which always characterized him, he stated in his second paragraph the aim of the system, which turned out to be the aim

of his own life: To harmonize the interests of the employer and of the employee; to give justice to the employee; to conform also to the best interests of the employer.

We have here Mr. Gantt's fundamental claim to leadership—*Harmony based on Justice.*

His last published utterance was in the New York *World*, Sunday, October 12, 1919. Speaking of industrial unrest, he said:

"No permanent peace is possible so long as one man is able to exploit the services of another for his own benefit."

In all his lectures and books in between these two dates he never deviated from the convinction of harmony based on justice. Therefore on this count of good will he was qualified as a leader.

The second qualification for authority, for leadership, is competence, is ability. The eminent position to which Mr. Gantt rose, his financial success, is the practical tribute paid to his competence and ability, but more than that his ability was recognized and deferred to by his own competitors in his younger days, his own friends in his last years.

The third quality essential to leadership is courage. Anybody who knew Mr. Gantt, who looked at his white head and heavy jaws and chin, knew that he was in the presence of a fighter.

He had physical courage;
He had mental courage;
He had spiritual courage.

There was never in anybody's mind any doubt as to where Mr. Gantt stood, whether he was leading you, at your side, or in behind you, you knew he was there and to be counted on.

The final quality essential to leadership, to authority, is personal charm.

We not only respected and depended on Mr. Gantt; we liked him. He could disagree without offending, and even in his wrath he was lovable. He furiously resented what he considered injustice, but he would come around into the wind as a full-sailed ship does turning a cape. Therefore we find in rugged form in Mr. Gantt that great quality of charm.

The noblest monument we can erect to him is to carry on his ideals. He had no faith in government machinery as government is at present organized.

His ideal held to and illustrated by his life should be ours: Harmony based on Justice.

To Whom Credit Is Due

The social affairs of the Annual Meeting of the A.S.M.E., which were so great a success this year, as well as the professional features, were directly in charge of the Committee on Meetings and Program, the membership of which is Prof. Dexter S. Kimball, *Chairman*, Walter Rautenstrauch, A. L. DeLeeuw, W. G. Starkweather, and R. V. Wright. As a result of experience in conducting previous conventions, an organization was perfected this year whereby a member of the Committee on Meetings and Program, Mr. R. V. Wright, was made general Chairman of a Sub-Committee for the Annual Meeting, with various sub-divisions devoted to the different activities.

Of these sub-divisions the general Social Functions were in charge of R. F. Jacobus, *Chairman;* President's Reception, Frederick A. Scheffler, *Chairman;* Dance, E. Van Winkle, *Chairman;* Reunion, F. T. Chapman, *Chairman;* Acquaintanceship, Hazen G. Tyler, *Chairman;* Excursions, H. J. Marks, *Chairman;* Catering, Edric B. Smith, *Chairman;* Ladies, Mrs. H. C. Spaulding, *Chairman.* The President's Reception Committee was assisted by the Sections delegates who were present at the meeting, together with a number of the local members.

An effective department of headquarters was the Information Bureau to which Prof. Charles C. Sleffel of Columbia University gave his personal attention, proving to be a second "Mr. Foster."

All of the events of the meeting were conducted with smoothness and in a way that created general satisfaction and gave the greatest possible pleasure to the guests in attendance. For this, credit should not only be given to the Committee on Meetings and Program, and the special committees mentioned, but to the personal efforts of Mr. S. N. Castle, of New York, who gave the results of his experience in his work in past years for the benefit of the committee members, and materially assisted in organizing and coördinating the work.

Index to Volume 41 of Mechanical Engineering

An index to Volume 41 of MECHANICAL ENGINEERING is now in the course of preparation, which, it is expected, will be issued early in February. A copy of this index will be sent to each member of the Society or subscriber who sends in a written request therefor. In order that no more copies than are necessary to supply the demand may be printed, requests for copies should be received at headquarters not later than February 1.

DREDGING PUMP OF NOVEL CONSTRUCTION

(Continued from page 7)

by Colonel F. B. Maltby and a careful study of the latter's paper in Vol. LIV, Trans.Am.Soc.C.E., has been of material assistance in the preparation of this paper. Colonel Maltby has also very kindly offered suggestions and criticisms during the preparation of this paper.

In a hydraulic pipe-line dredge of the cutter type it is believed that all passages through pipes and pump should be designed so that clogging at any point by more or less irregularly shaped solids will be reduced to a minimum. As a result of tests and also based on observation of the dredges in operation, it is the conclusion of the writer that the modifications described did not decrease the efficiency or capacity of the main engines and pumps, but did greatly increase the output of the dredges as excavating machines.

TABLE 3 DREDGING YARDAGES AND COSTS

Year 1918-1919]	Yardage Excavated	COSTS							
		Arbitrary	Unit Cost	Charter	Unit Cost	All Other Charges	Unit Cost	Total	Unit Cost
May, June and July	383,643			74,887.19	196	12,143.72	.031	87,030.89	.227
August	291,256	9,524.07	.015	90,547.20	.245	11,053.66	.034	111,124.93	.294
September	578,065	18,902.72	.022	63,993.60	.183	44,602.56	.054	127,498.88	.259
October	734,056	24,003.63	.027	62,486.40	.147	53,717.97	.061	140,208.00	.235
November	427,522	13,979.97	.028	54,566.40	.143	77,431.04	.082	145,977.41	.253
December	597,488	19,534.82	.028	66,628.80	.138	61,053.99	.086	147,217.61	.252
January	498,340	15,295.72	.029	64,145.76	.136	80,726.85	.097	160,168.33	.262
February	455,159	14,883.70	.029	57,874.80	.136	45,607.02	.096	118,365.52	.261
March	222,508	7,266.01	.029	24,807.55	.133	35,857.67	.101	67,931.23	.263
April	167,481	5,476.63	.029	19,027.80	.133	22,203.91	.102	46,708.34	.264
May	94,777	3,099.20	.030	12,724.80	.133	6,028.60	.101	21,852.60	.264
June	130,386	4,263.62	.030	13,915.20	.132	8,376.64	.100	26,555.46	.262
July	141,233	4,618.32	.030	14,275.20	.131	3,528.24	.098	22,421.76	.259
Preliminary and Auxiliary	477,193								
Total	5,199,107	140,848.41	.027	619,880.68	119	462,331.87	.089	1,223,060.96	235

All Yardages Computed from Sections Plotted from Soundings. Above Total Yardage is 70% of Estimated Yardage for Entire Project. Unit Cost Apply for Total Yardage Through Month Shown.

LIBRARY NOTES AND BOOK REVIEWS

THE ANALYSIS OF MINERALS AND ORES OF THE RARER ELEMENTS. For Analytical Chemists, Metallurgists, and Advanced Students. By W. R. Schoeller and A. R. Powell. J. B. Lippincott Co., Philadelphia, 1919. Cloth, 6 x 9 in., 239 pp., tables.

This is a practical laboratory guide for those interested in the determination of the so-called rare elements, and is the first work, the authors state, in which the complete analysis of the minerals of these elements has received systematic treatment. The methods have been selected from various authorities, supplemented when necessary by methods devised by the authors. Full details are given in each case.

ASBESTOS—FROM MINE TO FINISHED PRODUCT. Asbestos and Mineral Corporation, New York, 1919. Cloth, 10 x 11 in., 194 pp., 60 pl.

A collection of sixty photographs of asbestos minerals, mines and manufacturing plants, forming a pictorial presentation of the mining of raw asbestos and its manufacture into finished goods. Brief explanatory notes accompany the illustrations.

CATALYSIS IN INDUSTRIAL CHEMISTRY. By G. G. Henderson. Longmans, Green & Co., New York. Cloth, 6 x 9 in., 202 pp.

This, the latest volume of the series of Monographs on Industrial Chemistry which is being published under the editorship of Sir Edward Thorpe, is intended to present broadly our present knowledge of the phenomenon of which it treats. The book reviews the existing literature on catalysis, paying particular attention to the many and varied applications now used in industry. The author hopes that it will also suggest the desirability of further investigations.

COMMERCIAL OILS—VEGETABLE AND ANIMAL. With special reference to Oriental Oils. By I. F. Laucks. First edition. John Wiley and Sons, Inc., New York, 1919. Cloth, 5 x 8 in., 138 pp.

This book is intended to give men, without technical training, who are in the oil trade, the technical data and information required in everyday dealings, in concise form. The various commercial oils are listed. For each are given the sources, uses, and the physical and chemical characteristics. The values have been collected from the standard texts, supplemented, particularly in regard to oriental oils, by the results obtained in the author's laboratory.

THE CONDENSED CHEMICAL DICTIONARY. A reference volume for all requiring quick access to a large amount of essential data regarding chemicals, and other substances used in manufacturing and laboratory work. Compiled and edited by The Editorial Staff of the Chemical Engineering Catalog. The Chemical Catalog Company, Inc., New York, 1919. First edition. Cloth, 6 x 9 in., 525 pp.

This volume has been prepared to meet the need for a concise summary of the properties of chemicals. The arrangement of the book is alphabetical. The information given includes variant names, formulas, color and properties, constants (boiling and melting points, specific gravity, etc.), derivation, method of purification, grades obtainable, containers, uses, fire hazard and shipping regulations. Substances made in America are indicated. The volume is fully cross-indexed, and includes a number of useful tables of weights and measures, thermometric scales, etc. Synthetic dyes are omitted. While the compilers state that no attempt has been made to be exhaustive, but merely to give the outstanding facts concerning the chemicals ordinarily met in commerce, approximately six thousand substances are included.

ELEMENTS OF RADIOTELEGRAPHY. By Ellery W. Stone. D. Van Nostrand Co., New York, 1919. Flexible cloth, 5 x 8 in., 267 pp., 125 illus., 33 pl.

This book, by the instructor at the U. S. Naval Radio Station, San Diego, was written primarily for use in instruction at that school; it is believed, however, that it will be helpful in other schools and for self-instruction. The physical rather than the mathematical presentation of the subject is used. A knowledge of physics and mathematics is not necessary. Prominence is given to the development of the subject as illustrated by patents.

FIFTY YEARS OF IRON AND STEEL. By Joseph G. Butler, Jr. The Penton Press, Cleveland, 1919. Leather, 6 x 10 in., 145 pp., portraits.

This volume is one of a special edition, limited to one hundred copies, of an address delivered before the American Iron and Steel Institute in 1917, in which the author gives his personal reminiscences of the development in iron and steel making as observed during an active participation in the industry in eastern Ohio, which began in 1857. To this are added some brief data on the early history of iron and steel, and a chapter on the activities of the American iron manufactures during the great war. The volume is profusely illustrated with portraits of men of note in the industry.

FOREST PRODUCTS. Their Manufacture and Use. Embracing the Principal Commercial Features in the Production, Manufacture, and Utilization of the Most Important Forest Products Other than Lumber, in the United States. By Nelson Courtlandt Brown. First edition. John Wiley and Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 471 pp., 120 illus., 1 pl., tables.

The object of this book is to provide a brief account of the chief commercial features involved in the manufacture and use of such products as wood pulp and paper, tanning materials, veneers, cooperage, naval stores, distilled products, charcoal, maple sugar and syrup, dye woods, rubber, cork, excelsior, shingles, mine timbers, etc., which will serve as a text for students and as a book of reference. The volume reviews a field in which, the author states, but little has been written on American practice. Brief bibliographies are appended to the chapters.

GEODESY. Including Astronomical Observations, Gravity Measurements, and Method of Least Squares. By George L. Hosmer. First edition. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 368 pp., illus., tables.

The author has endeavored to produce a textbook adapted to a course of moderate length which would make clear the underlying principles and emphasize the theory as well as the details of field work. The methods of observing and computing given are consistent with the practice of the Coast and Geodetic Survey.

HAND-BOOK OF FIRE PROTECTION. By Everett U. Crosby, Henry A. Fiske and H. Walter Forster. Sixth edition. D. Van Nostrand Company, New York, 1919. Flexible cloth, 5 x 7 in., 757 pp., illus., tables.

This work has long been a standard reference book for insurance engineers and inspectors, in which those methods of fire protection which have crystallized into good practice are collected and presented concisely. The present edition has been enlarged by new chapters and illustrations, and has been carefully revised.

HYDROLOGY. The Fundamental Basis of Hydraulic Engineering. By Daniel W. Mead. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 647 pp., illus., maps, tables.

Lack of knowledge of the fundamentals of hydrology and of the importance of hydrological factors has been responsible, the author believes, for more failures in hydraulic-engineering projects than defects in structural design. To assist in removing this ignorance he has here set down some of the more important facts and principles, omitting everything that his long experience has not shown to be of practical importance. Carefully selected lists of references are appended to each chapter, to enable readers to complete their study of any phase of the subject which has not been sufficiently treated within the limits of the book itself.

A MANUAL OF PHYSICAL MEASUREMENTS. By Anthony Zeleny and Henry A. Erikson. Fourth edition. Cloth, 5 x 8 in., 261 pp., 129 illus., tables.

This manual is an outline of the laboratory course given to students of general physics at the University of Minnesota. One hundred and thirty-three experiments are included. Directions